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THOMAS HENRY HUXLEY: SOME PERSONAL MEMORIES[1]

By his son,
LEONARD HUXLEY

The Editor asks me to contribute a few personal reminiscences of my father in commemoration of his centenary birthday, May 4th. Across the shadows of the intervening years those memories rise clear in the strong light of his personality. He was a man you would notice at once in a crowded room; even passing him in the street you would look round at him a second time. An indefinable impression of power made itself felt in his firm carriage, his penetrating look, his close-pressed but mobile lips; and not power alone, but power schooled to good ends. Here surely was something to look up to and trust; justice implacable to pretence, but tender when sympathy was due; with knowledge not aloof from life, but, as Sir Walter Besant described it, a face "beautiful for wisdom and the kindliness of it."

It did not take long to discover that the foundation of this was a deep-rooted veracity in him, both intellectual and moral. This was the keynote of his life and his life's work. It was summed up in the words, Learn what is true in order to do what is right * * * .

He was stiffened in the search for realities and hatred of shams by the preaching of Carlyle. To smite all humbugs, wherever met; to help the minds even more than the bodies of the poor and miserable such as he had worked among when a doctor's apprentice at Rotherhithe—these were resolves to which Carlyle early gave shape and determination.

Truth of fact first; that lay in accurate knowledge of Nature and the correction of man's thoughts and theories by the test of fact. Hard work; but harder still the duty of acting on this principle in daily life, and finally to live free from compromise with codes and theories that were manifestly ill-based. Truthfulness, it might be said, became his vital religion, the common basis of intellectual progress and social life. Veracity was the first essential in his associates. No matter how near in intimacy or how influential in his field of work, he broke absolutely with any he could not trust in word and act.

It was a fierce sincerity, as the world came to know, hot against falsehood, cruelty, wrongdoing no less than the half sincerities of foggy thought and the "sin of faith" which prostitutes reason by giving assent to propositions which are neither self-evident nor adequately proved, but yet a sincerity respecting equal sincerity in the opposite camp.

[1] Reprinted from *John O'London's Weekly*. London, May 3, 1925.

It was, I think, an undefined sense of this consuming veracity in him, this moral as well as intellectual force, which invested him in our childish eyes with a kind of awe over and above other feelings. Sincerity demanded its like, and in his presence childish pretences and insincerities shrivelled away * * * .

I have often been asked if we did not get a wealth of scientific instruction from him. As a matter of fact he had a horror of thrusting his own "shop" upon us. He wanted us, I know, to grow up individually and independently, following our natural bents. He would not crudely bend the twig by external pressure, * * * . All the same we had our share of sea stories and tales about animals and suggestive nature pictures from the gravels of the Heath. Like everything, he said, it was stimulating, not oppressive; I am sure we could have delightedly borne much more without reaching the saturation point he dreaded.

Equally stimulating, equally lasting in effect, even to a small child, were his lectures at the London Institute which afterwards took shape in his "Physiography"; they linked on, as it were, to his unstudied talk.

Naturally we were not conscious how good this "talk" was. It was not till later, after reading his essays among other literature, after hearing other lecturers and listening to other talkers of repute, that one gradually came to realize how rich in substance, how brilliant in form, his discourse always was, how instinctively adapted to the person addressed, and moreover, how happily seasoned with humour and good-humour, with quick wit and allusive point.

One came to realize, also, that he had impressed himself upon us not by mere words of admonition and preachment, but by being himself and acting steadily up to his beliefs. Moreover, we knew that if new facts turned up to alter his conclusions, if good reason could be shown for breach of a convention that had ceased to be reasonable, he would never hesitate to admit error or to abandon a long accepted custom of daily conduct.

The man of science is often supposed, especially by the writer of popular fiction, to be merely contemplative, a dreamer, lost in the clouds. Here at least was one filled with an intense love of pure knowledge, yet with an equally intense practicality which went much further than administration in his own departments. "If I were not a man," he exclaimed, on seeing the busy tugs at work in New York Harbour, "I should like to be a tug." In his mind, science was not solely for the men of science, but for the people, who "perish for lack of knowledge." Science should not only yield material fruits to alleviate men's miseries and promote their welfare; his constant object was through science to help the struggling world to ideas which should aid men to think truly and so to live rightly. Fulfilment certainly came to his hope that he "had somewhat helped that movement of opinion which has been called the New Reformation," and it was not in vain that he wrote of his labours, "If I am to be remembered at all, I should like to be remembered as one who did his best to help the people."

THE SWEET POTATO WEEVIL (CYLAS FORMICARIUS, FABR.)[1]

SALUSTIANO S. GONZALES

WITH THREE PLATES

INTRODUCTION

Among the worst enemies of the sweet potato, *Ipomœa batatas* (L.) Poir, which is perhaps the leading root crop of the Philippines, is the sweet potato weevil, *Cylas formicarius* Fabr.[2] Great damage is done by this insect in the sweet potato fields, resulting often in enormous losses. Yet no effort to speak of has been made in the way of eradicating the pest. The species is apparently of world-wide distribution.

The original home of this insect has not been definitely determined. There are conflicting reports; as for instance, those of Fullaway (1911), Orton and Chittenden (1917), and Chittenden (1918), who ascribe the native habitat of this species to Cochin-China; an anonymous correspondent in the *Journal of the Department of Agriculture*, Union of South Africa (1924), who supposes that the probable place of origin is Africa; and another anonymous correspondent in the *Memoirs of the Department of Agriculture*, India (1910), who suggests India. The following is a partial list representing the geographical range of the pest.[3]

PALÆARCTIC REGION

Countries	*Authorities*
Asia (continental?)	Chittenden (1919)

ETHIOPIAN REGION

Countries	*Authorities*
South Africa	Anonymous (1924)
Africa	Chittenden (1919)
Madagascar	Chittenden (1919)
	Crosby and Leonard (1918)
	Fullaway (1911)

[1] Thesis presented for graduation, 1925, with the degree of Bachelor of Agriculture, from the College of Agriculture, University of the Philippines, No. 205; Experiment Station contribution No. 311. Prepared in the Department of Entomology under the direction of Associate Professor L. B. Uichanco.

[2] Authorities differ as to the identity of this species. We have specimens in the collections of both the College of Agriculture and the Bureau of Science, which are also labeled *Cylas turcipennis* Bohm.

[3] The classification into geographical regions is patterned after:

Sclater, William L., and Philip L. Sclater: The geography of mammals. 1899. 335 p. London.

The following references were also consulted:

Wallace, Alfred Russel: Geographical distribution of animals. 1876. 1. 503 p. London.

Wallace, Alfred Russel: Island life. 1902. 563 p. London.

ORIENTAL REGION

Countries	*Authorities*
Cochin-China	Crosby and Leonard (1918)
Formosa	Chittenden (1919)
India	Anonymous (1910) Chittenden (1919) Crosby and Leonard (1918) Fullaway (1911)
Philippines	Sarmiento (1924) Kingman and Doryland (1917)
China (south-eastern?)	Fullaway (1911)

NEARCTIC AND NEOTROPICAL REGIONS

Countries	*Authorities*
United States (mainly Southern States)	Bragdon (1917) Cates (1923) Chittenden (1918) and (1919) Crosby and Leonard (1918) Fernald (1921) Graf & Boyden (1921) Herrick (1918) Hinds (1918) Newell (1917) O'Kane (1920) Orton and Chittenden (1917) Pierce (1918) Reinhard (1923) Sanderson (1912) Smith (1923)
Porto Rico	More (1921)
West Indies	Chittenden (1919) Crosby and Leonard (1918) Fullaway (1911)

AUSTRALIAN REGION

Countries	*Authorities*
Australia	Chittenden (1919) Crosby and Leonard (1918) Fullaway (1911)
Hawaii	Chung (1923) Fullaway (1911)

In the United States where the pest, according to Crosby and Leonard (1918), Fernald (1921), Sanderson (1912), and Smith (1923) was first authoritatively reported in 1875, Chittenden (1919) states that losses in sweet potato crop due to this cause range from 12 to 50 per cent, while Cates (1923) estimates the value at $3,000,000 a year. The pest is present in every part of that country where sweet potatoes are grown, but is especially bad in the Southern States. It has been thoroughly studied in various states and comprehensive reports on the subject published from the states of Florida, Texas, and Louisiana by Orton and Chittenden (1917), Chittenden (1919), Smith (1923), and O'Kane (1920), while additional reports were published by Herrick (1918) from Mississippi, Alabama, and Georgia. The year-books of the United States Department of Agriculture for 1905, 1907, and 1908 also contain references on this species.

The object of the present work was to study the biology of the insect with special reference to possible control methods applicable under Philippine conditions. The work was begun in April of 1923 and carried on to February 28, 1925. Experiments were conducted in both the fields and the entomological laboratory of the College of Agriculture, University of the Philippines, at Los Baños, Laguna.

MATERIALS AND METHODS

The insects were reared in glass jars covered at the mouth with cheese cloth; roots of sweet potatoes were supplied as food. Small, wide-mouthed bottles with cotton plugs were also used. Vials were likewise found handy in connection with certain parts of the experiments.

For anatomical studies, the material was prepared as follows:

Eggs. Eggs of varying stages of development were collected. These were fixed in hot water at about 80° C. and then punctured and preserved in 70 per cent alcohol. Whenever needed for study they were mounted on slides.

Larvæ and pupæ. These were also fixed in hot water at about 80° C. They were then punctured and preserved in 70 per cent alcohol, as in the case of the eggs.

Adults. For specimens to be mounted *in toto,* for general anatomical work, it was immaterial whether adults which had previously dried up were used or freshly killed insects. After puncturing the body walls, the insects were macerated in 5 per cent aqueous solution of potassium hydrate, washed in several changes of water, dehydrated and mounted in balsam, as in ordinary slide preparations. The appearance of cloudiness in the mount was obviated by using carbol-xylene in the proportion of 1 to 3 as clearing agent, instead of xylene alone. For detailed anatomical work, where the minute structures of the sclerites were to be considered, it was found essential to use specimens which had freshly emerged from the pupal cases, prior to hardening and darkening of the chitinous exoskeleton. With this exception, the steps followed were similar to those described above.

All measurements were made with the aid of a previously calibrated eyepiece micrometer. Illustrations were drawn with the aid of a camera lucida.

EXPERIMENTS AND RESULTS

A. BIOLOGY OF CYLAS FORMICARIUS

Life history

Copulation, oviposition, and fecundity. The female settles on the surface of the root and with her snout makes a preliminary examination of various spots on the surface without changing the position of her body. After a suitable place is located, she begins to bore a hole which is as large as, or a little larger than, the diameter of the head. She continues to eat deeper and deeper until the head is almost buried in the hole and the thorax touches the rim of the opening. The abdomen naturally becomes tilted gradually upward as the hole grows deeper, so that the exposed part of the body ultimately describes an angle of about 30° with the surface of the root. In this position, the fore and middle legs are shoved together and directed anteriorly, while the hind pair is held apart posteriorly. When a certain depth is reached, usually after more than one half of the total length of the snout is buried, the insect stops and turns around, pivoting herself on the center of the body. She then locates the hole by means of the metathoracic legs and inserts the caudal end of the abdomen. The insect stays five or more minutes in this position, and when she leaves, the hole can be seen covered with

a black or grayish mass, protecting a single egg. The process is repeated with each subsequent oviposition on other spots on the surface of the root. In all cases observed, only one egg was found to be laid in each hole.

The length of time from the emergence of the adult females to the laying of the first set of eggs by these females was found to vary greatly with the individual. As has been stated previously, newly emerged adults are very soft and helpless. Several days are needed for these insects to harden sufficiently to be able to escape from the pupal cavity in the root. After reaching the open air, the female has to wait for some time before she can be mated, the period depending upon the number of males available. The larger the number of the latter, the better, of course, is her chance for early pairing.

TABLE 1

Time from emergence of female to laying of first eggs

CULTURE NUMBER	ADULTS EMERGED	FIRST EGGS LAID	TOTAL
	1923	1923	*days*
1	16–IX	24–IX	8
2	19–IX	29–IX	10
3	17–IX	24–IX	7
4	17–IX	24–IX	7
5	15–IX	25–IX	10
6	17–IX	25–IX	8
7	17–IX	24–IX	7
8	18–IX	25–IX	7
9	19–IX	27–IX	8
10	19–IX	25–IX	6
11	27–IX	4–X	7
12	27–IX	4–X	7
13	27–IX	5–X	8
14	29–IX	6–X	7
15	27–IX	5–X	8
16	28–IX	6–X	8
17	27–IX	5–X	8
18	26–IX	4–X	8
19	5–X	12–X	7
20	11–X	18–X	7
	1924	1924	
21	27–IV	4–V	7
22	26–IV	3–V	7
23	26–IV	6–V	10
24	28–IV	7–V	9
25	26–IV	4–V	8
26	28–IV	5–V	7
27	28–IV	5–V	7
28	29–IV	7–V	8
29	6–V	15–V	9
30	4–V	10–V	6
31	7–V	14–V	7
32	5–V	12–V	7
33	6–V	14–V	8
34	6–V	16–V	10
35	4–V	11–V	7
36	6–V	13–V	7
37	11–V	17–V	6
38	15–V	22–V	7
39	15–V	25–V	10
40	18–V	25–V	7
Minimum			6
Maximum			10
Average			7.67

Table 1 shows this period to vary from 6 to 10 days, with an average of 7.63 days. These figures are based on 40 cultures.

The adult females upon emergence were kept separately in small wide-mouthed bottles and a male confined with each. Pieces of sweet potato roots were put into each bottle. Daily observations were made to find whether or not the female had oviposited. The pieces of roots were changed daily until the first set of eggs was laid.

The number of eggs laid daily by each female was determined as follows:

Thirty cultures were used; these were divided into two lots of 15 each. Experiments on one lot were performed during the dry season, and on the other, during the rainy season. In these experiments, precaution was taken to slice the roots examined for presence of eggs into tolerably thin pieces so as to obviate the possibility of any of the eggs escaping detection.

Results of these experiments are shown in tables 2-a and 2-b. Table 2-a represents results from dry season experiments. Table 2-b is from an experiment begun late in the dry season and carried on through the larger part of the rainy season to note the effect of seasonal changes.

From the foregoing data it may be seen that there was no regularity in the number of eggs laid daily by each female. Intervals of one or more days often occurred between ovipositions. The eggs laid in one day varied from 1 to 12, with an average of 3.06 eggs. The females of cultures XII and XIII deposited 10 eggs and 12 eggs, respectively; but these rates were obtained only once during the entire period of fecundity of the mothers, so that such cases should be considered exceptional rather than a common occurrence. The prevailing rate of daily oviposition appears to range from one to six. In the majority of instances seven eggs in one day were obtained at irregular intervals. Successive daily ovipositions of eight and nine eggs were very rare. It should be noted further that the rate of oviposition varied greatly with the individual, seasonal conditions having very little, if any, effect thereon. This fact is confirmed by the data shown in tables 2-a and 2-b, wherein there is practically no difference in the number of eggs laid daily by each female between cultures in the dry-season and those in the rainy-season sets. These tables further show that the total number of eggs laid by one female during the entire period of fecundity varies from 90 to 340, with an average of 256.03. This number is, of course, correlated with the daily rate of oviposition and the relative duration of the egg-laying period of the individual.

In the preceding experiments, the period of fecundity of the female was also determined more or less extensively. This period was taken to begin with the date when she first oviposited and end with the time when she ceased laying.

TABLE 3

Period of fecundity

NUMBER	FIRST EGG LAID	LAST EGG LAID	TOTAL
	1924	1924	days
1	20–I	13–IV	85
2	20–I	14–IV	86
3	21–I	21–IV	92
4	20–I	14–IV	86
5	20–I	19–IV	91
6	24–I	22–IV	90
7	20–I	20–IV	92
8	20–I	20–IV	92
9	20–I	13–IV	85
10	20–I	8–IV	80
11	20–I	31–III	72
12	21–I	19–IV	90
13	20–I	13–IV	85
14	23–I	14–IV	83
15	21–I	21–IV	92
16	27–IV	22–VII	87
17	27–IV	18–VII	83
18	26–IV	5–VII	71
19	26–IV	12–VII	78
20	30–IV	22–VII	84
21	29–IV	23–VI	56
22	29–IV	30–VII	93
23	25–IV	13–VII	80
24	28–IV	26–VII	90
25	25–IV	23–VII	90
26	25–IV	30–IV	6[a]
27	27–IV	22–VII	87
28	28–IV	19–VII	83
29	29–IV	22–VII	85
30	27–IV	22–VII	87
Minimum			56
Maximum			93
Average			84.65

[a] Apparently abnormal; excluded from computation.

Table 3 shows that the period of fecundity of each female ranged from 56 to 93 days with an average of 81.83 days. The table shows further that this period, as with daily rate of oviposition, varied greatly with the individual and had little, if anything, to do with seasonal conditions.

Referring again to tables 2-a and 2-b it may be seen that the daily rate of oviposition is not perceptively influenced by the age of the mother. There were even a few instances in which the female, near the time of her death, continued ovipositing at about the same rate as during the beginning of her egg-laying period.

TABLE 2-a

Number of eggs laid daily by each female during entire egg-laying period (Dry-season experiments)

DATE	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV	XV
1924															
20–I	3	1		2	2		3	1	3	2	1		1		
21–I	3	1	4	4	5		2	4	5	4	1	3	5		2
22–I	6	4	3	1	5		3	2	1	4	1	5	2		4
23–I	2	2	4	2	4		5	2	3	3	4	4	3	5	3
24–I	4	2	3	5	4	4	5	2	2	5	3	2	3	5	1
25–I	5	2	2	4	6	3	2	6	4	2	1	4	2	3	2
26–I	2	3	5	2	4	4	5	5	3	2	2	4	3	5	2
27–I	6	4	6	3	3	5	4	3	2	4	1	2	5	3	3
28–I	4	6	3	4	7	6	6	3	5	1	2	3	4	2	4
29–I	4	2	3	5	4	4	3	6	2	1	3	2	4	2	5
30–I	4	3	4	5	2	3	4	4	1	1	1	1	3	6	4
31–I	3	5	6	3	5	5	2	4	5	5	2	4	3	3	3
1–II	5	4	3	6	3	5	2	4	2	3	2	4	5	2	2
2–II	3	7	5	2	1	4	3	7	4	6	3	5	2	4	1
3–II	5	3	4	0	1	3	5	4	1	2	1	3	5	2	3
4–II	4	3	4	0	2	3	1	3	4	3	1	4	3	3	1
5–II	3	2	5	0	4	4	3	6	3	3	1	2	6	5	4
6–II	3	3	4	3	0	5	4	3	4	3	0	5	3	3	5
7–II	5	5	6	5	2	3	5	3	3	3	0	5	3	4	2
8–II	7	5	4	2	6	3	5	5	3	0	2	3	3	0	1
9–II	4	3	4	4	5	4	6	3	2	2	4	2	5	2	5
10–II	5	6	5	4	2	1	3	4	1	1	4	4	2	6	3
11–II	0	4	3	1	4	1	4	2	4	3	1	3	1	4	4
12–II	4	1	4	6	5	2	2	6	4	6	1	2	4	3	1
13–II	6	5	0	3	3	2	3	3	0	4	2	4	3	3	3
14–II	5	4	2	3	3	2	4	5	2	1	3	1	2	2	4
15–II	5	3	3	4	3	5	1	4	2	3	3	1	5	3	6
16–II	3	5	5	6	3	4	5	2	5	5	2	0	1	5	2
17–II	3	2	7	5	5	1	4	4	2	3	2	4	2	4	2
18–II	4	2	4	3	0	3	3	3	3	4	2	3	1	1	3
19–II	1	6	3	1	1	4	3	3	4	2	0	5	4	5	5
20–II	5	4	4	3	1	2	2	4	1	6	0	2	5	4	5
21–II	3	3	1	4	1	3	5	4	3	5	0	3	2	3	4
22–II	6	6	6	2	3	6	4	2	2	3	1	3	2	5	3
23–II	4	5	3	1	4	5	4	6	3	2	4	3	2	5	6
24–II	4	4	5	3	5	2	3	4	4	4	2	1	1	0	4
25–II	3	3	5	4	2	2	0	1	4	3	2	1	1	1	3
26–II	5	4	4	6	4	4	0	1	2	2	2	4	2	4	0
27–II	2	6	0	5	6	5	3	5	2	6	5	2	7	2	0
28–II	3	5	1	2	5	1	2	6	2	4	0	2	5	3	2
29–II	4	2	2	1	5	1	5	3	3	4	2	6	3	1	5
1–III	6	2	2	4	3	4	5	4	1	4	1	1	6	3	6
2–III	4	1	3	3	2	2	2	3	4	2	2	4	2	4	4
3–III	3	0	4	3	2	3	1	2	3	5	2	2	4	2	4
4–III	3	4	2	5	3	6	4	5	3	1	3	1	4	0	3
5–III	4	3	3	1	2	4	2	2	2	1	6	1	4	0	1
6–III	6	4	4	6	2	1	2	2	4	2	1	1	1	5	2
7–III	4	4	4	4	4	5	2	1	1	4	4	1	1	2	4
8–III	5	5	5	2	5	2	2	4	0	3	3	1	2	4	4
9–III	5	5	2	3	5	0	4	3	2	3	3	1	5	4	6
10–III	4	2	1	3	4	2	2	5	2	5	2	2	2	1	2
11–III	6	2	4	4	1	1	4	2	4	4	4	4	6	3	4
12–III	3	4	3	2	6	1	1	4	1	0	2	6	4	3	4
13–III	2	1	0	2	4	2	5	3	2	2	1	1	4	2	1
14–III	4	4	2	1	3	4	0	6	2	3	1	2	4	3	3
15–III	4	3	4	0	4	5	4	2	3	3	1	2	2	3	5
16–III	2	3	1	0	2	3	5	2	5	3	1	1	2	3	2
17–III	1	5	5	1	5	4	3	5	5	4	3	1	3	3	2
18–III	3	3	3	5	5	4	4	4	4	5	5	4	3	8	4
19–III	4	5	4	3	5	5	1	0	2	2	2	5	4	2	0
20–III	3	2	5	5	2	2	1	3	2	4	0	6	2	3	0
21–III	4	3	2	2	5	3	2	4	3	3	0	4	4	3	2
22–III	3	3	4	0	2	4	4	5	2	4	0	6	5	3	3
23–III	5	5	4	1	5	3	4	5	6	5	6	5	2	0	3
24–III	2	2	0	1	1	1	6	0	2	2	1	3	5	2	3
25–III	6	2	3	0	1	1	4	3	1	1	1	3	3	5	5
26–III	2	6	5	0	2	5	0	3	4	2	1	4	4	5	4
27–III	3	2	4	0	5	5	3	5	3	4	3	3	5	3	1
28–III	5	4	1	0	4	3	2	5	3	2	0	5	2	2	0
29–III	0	3	2	0	2	1	1	2	3	0	0	2	3	1	0
30–III	2	4	2	2	5	2	2	3	5	0	1	4	2	2	2

TABLE 2-b

Number of eggs laid daily by each female during entire egg-laying period (Rainy-season experiments)

DATE	I	II	III	IV	V	VI	VII	VIII	IX	X	XI *a*	XII	XIII	XIV	XV
1924															
25–IV								1		1	1				
26–IV			4	3				3		2	2				
27–IV	6	4	4	5				4		4	2				
28–IV	3	5	5	5				6	3	3	2	4	3		5
29–IV	5	6	3	6		1	3	3	4	2	2	4	6	3	5
30–IV	7	3	2	3	2	1	4	4	5	9	1	2	3	0	5
1–V	5	1	4	3	3	0	2	3	2	4	0	2	3	2	5
2–V	3	2	0	3	4	1	3	2	0	2	0	2	5	2	4
3–V	6	3	5	3	2	2	5	4	2	5	0	3	2	3	6
4–V	3	0	6	2	3	1	1	4	1	3	0	1	2	2	2
5–V	5	1	4	2	5	1	2	2	1	6	0	2	7	2	5
6–V	4	0	2	1	3	1	3	5	1	2	D	4	3	2	6
7–V	6	2	5	1	3	1	3	3	1	5		4	2	1	3
8–V	7	0	5	1	2	4	2	4	0	4		3	3	1	6
9–V	3	0	1	4	3	2	1	3	0	3		3	1	2	4
10–V	3	0	2	2	6	2	1	6	0	2		4	0	1	3
11–V	5	1	3	0	3	1	4	4	0	6		3	0	2	6
12–V	5	5	0	3	3	3	5	3	0	1		5	3	2	4
13–V	3	2	2	4	5	2	5	3	0	4		5	2	0	3
14–V	4	0	4	6	2	1	1	4	0	5		1	5	1	4
15–V	5	1	1	2	3	0	3	2	0	3		2	2	1	7
16–V	4	4	5	4	1	1	3	5	0	2		5	4	0	5
17–V	5	2	4	3	2	1	3	5	0	2		5	0	1	2
18–V	3	6	3	1	2	3	0	3	0	2		3	3	1	2
19–V	3	4	2	5	2	4	2	3	1	2		2	5	2	2
20–V	3	1	3	2	2	4	2	4	1	2		5	6	2	1
21–V	4	5	0	4	1	3	0	2	2	2		2	3	0	2
22–V	8	5	3	6	2	1	1	6	2	2		4	2	2	3
23–V	0	4	0	3	0	1	5	4	1	4		3	0	0	0
24–V	3	2	3	4	3	2	6	4	4	1		3	2	2	3
25–V	5	4	7	4	1	0	4	4	4	2		3	3	1	5
26–V	5	2	6	3	3	3	2	4	5	3		5	4	3	4
27–V	2	5	3	2	2	1	1	1	3	3		5	3	4	4
28–V	4	3	3	2	3	1	4	3	5	4		5	2	1	3
29–V	5	2	5	1	6	5	5	3	3	4		4	6	2	6
30–V	5	4	5	5	5	2	5	2	4	4		4	3	5	5
31–V	2	4	1	5	3	2	3	5	2	3		6	5	3	2
1–VI	6	4	6	6	4	1	2	4	3	4		3	4	4	5
2–VI	4	5	3	2	4	1	5	5	5	1		3	7	4	3
3–VI	2	2	4	1	3	1	2	5	6	4		3	5	2	6
4–VI	4	1	3	4	5	0	4	2	3	3		3	3	1	4
5–VI	4	2	2	3	4	0	2	1	1	5		3	1	4	4
6–VI	3	2	5	3	5	2	0	5	2	4		5	3	4	1
7–VI	4	4	3	2	5	2	4	3	5	3		5	4	3	3
8–VI	5	1	3	5	5	3	7	4	4	0		5	4	1	2
9–VI	1	2	6	4	6	1	3	6	4	0		4	3	5	4
10–VI	5	6	2	1	5	1	4	2	6	5		3	3	2	4
11–VI	4	2	5	1	5	1	6	4	5	3		4	5	6	5
12–VI	2	4	1	3	3	1	4	8	4	6		4	2	4	3
13–VI	3	4	4	3	4	2	3	3	2	6		4	3	4	3
14–VI	3	3	6	5	0	2	3	4	5	2		5	4	4	2
15–VI	4	6	5	1	4	1	5	6	4	1		2	5	1	4
16–VI	3	5	2	2	7	1	4	4	6	4		3	4	3	3
17–VI	5	5	4	2	5	4	6	3	5	4		3	6	2	3
18–VI	5	2	4	2	2	2	3	3	3	4		5	5	6	4
19–VI	5	4	3	3	3	1	5	4	3	5		4	2	4	3
20–VI	2	4	5	2	6	3	4	5	5	4		6	5	5	1
21–VI	3	3	4	2	3	1	4	5	3	0		3	2	4	6
22–VI	4	6	2	6	4	1	5	5	2	0		2	3	1	3
23–VI	5	5	0	2	4	2	7	3	3	2		4	1	3	2
24–VI	5	1	0	4	4	0	6	2	5	5		4	4	6	5
25–VI	1	4	3	5	5	0	4	3	1	1		3	6	3	4
26–VI	4	0	4	1	7	0	3	1	2	4		5	4	2	3
27–VI	3	3	6	3	4	D	5	1	0	4		1	4	4	1
28–VI	6	3	2	1	5		3	1	0	3		1	3	1	6
29–VI	4	3	1	5	5		3	4	4	2		1	1	5	3
30–VI	5	4	4	4	4		7	1	3	4		0	4	4	2
1–VII	2	1	3	1	2		5	5	6	5		0	2	3	4

TABLE 4

Time from laying of last egg to death of female

CULTURE NUMBER	LAST EGGS LAID	DEATH OF FEMALE	TOTAL
	1924	1924	*days*
1	13–IV	17–IV	4
2	14–IV	17–IV	3
3	21–IV	23–IV	2
4	14–IV	18–IV	4
5	19–IV	22–IV	3
6	22–IV	24–IV	2
7	20–IV	20–IV	0
8	20–IV	22–IV	2
9	13–IV	14–IV	1
10	8–IV	12–IV	4
11	31–III	9–IV	9
12	19–IV	20–IV	1
13	13–IV	15–IV	2
14	14–IV	17–IV	3
15	21–IV	22–IV	1
16	22–VII	25–VII	3
17	18–VII	21–VII	3
18	5–VII	9–VII	4
19	12–VII	16–VII	4
20	22–VII	24–VII	2
21	23–VI	27–VI	4
22	30–VII	1–VIII	2
23	13–VII	13–VII	0
24	26–VII	29–VII	3
25	23–VII	25–VII	2
26	30–IV	6–V	6*a*
27	22–VII	22–VII	0
28	19–VII	19–VII	0
29	22–VII	26–VII	4
30	22–VII	22–VII	0
Minimum			0
Maximum			9
Average			2.48

[a]Apparently abnormal; eliminated from computation.

Table 4 shows the length of time that the female survives her period of fecundity. It was found to vary from zero to nine days, with an average of 2.48 days. From these data it will be noted that the female is prolific during her entire life period, as adult, subsequent to copulation.

For the determination of the life history of the insect, eggs were saved in the pieces of roots where they were laid and placed in small wide-mouthed bottles. Great difficulty was encountered in life-history determinations, particularly with respect to the incubation period of the eggs, as the pieces of roots dried up very quickly. However, this trouble was remedied to some extent by using larger pieces of roots and placing them on moistened cotton. It was found that even partially exposed eggs hatched, although the percentage was smaller than in the case of those left imbedded in the plant tissues. In the latter case the percentage of hatching was almost always 100. In the present work, care was taken not to slice the roots any more than was absolutely necessary to note the presence of eggs. Presence of grayish or dark brown deposit served as auxiliary indication of the presence of eggs.

During the larval stage, the food material was changed often in order to detect metamorphic changes as soon as they occurred. When the pupal stage was reached, the insects were left undisturbed. They were examined daily to

keep track of their emergence. A life cycle in the present work was taken as the time which elapsed from the laying of an egg to the time of first oviposition by the female hatched from that particular egg. Only eggs which developed into females are represented in tables 5-a and 5-b.

TABLE 5-a

Life history of Cylas formicarius Fabr. (Rainy-season experiments)

LOT NO.	EGGS LAID	HATCHED	INCUBATION PERIOD	PUPATED	DURATION OF LARVAL STAGE	EMERGED	DURATION OF PUPAL STAGE	FIRST EGGS LAID	LENGTH OF LIFE CYCLE
	1923	1923	*days*	1923	*days*	1923	*days*	1923	*days*
1	7–VIII	15–VIII	8	9–IX	25	16–IX	7	24–IX	48
2	7–VIII	15–VIII	8	11–IX	27	19–IX	8	29–IX	53
3	7–VIII	15–VIII	8	9–IX	25	17–IX	8	24–IX	48
4	7–VIII	14–VIII	7	9–IX	26	17–IX	8	24–IX	48
5	7–VIII	13–VIII	6	7–IX	25	15–IX	8	25–IX	49
6	7–VIII	15–VIII	8	9–IX	25	17–IX	8	25–IX	49
7	8–VIII	15–VIII	7	10–IX	26	17–IX	7	24–IX	47
8	8–VIII	15–VIII	7	10–IX	26	18–IX	8	25–IX	48
9	8–VIII	17–VIII	9	9–IX	23	19–IX	10	27–IX	50
10	8–VIII	15–VIII	7	11–IX	27	19–IX	8	25–IX	48
11	17–VIII	25–VIII	8	19–IX	25	27–IX	8	4–X	48
12	17–VIII	25–VIII	8	19–IX	25	27–IX	8	4–X	48
13	17–VIII	25–VIII	8	19–IX	25	27–IX	8	5–X	49
14	17–VIII	25–VIII	8	21–IX	27	29–IX	8	6–X	50
15	17–VIII	25–VIII	8	19–IX	25	27–IX	8	5–X	49
16	17–VIII	26–VIII	9	20–IX	25	28–IX	8	6–X	50
17	17–VIII	25–VIII	8	18–IX	24	24–IX	9	5–X	49
18	17–VIII	24–VIII	7	18–IX	25	26–IX	8	4–X	48
19	1–IX	7–IX	6	28–IX	21	5–X	7	12–X	41
20	1–IX	9–IX	8	3–X	24	11–X	8	18–X	47
Min.			6		21		7		41
Max.			9		27		10		53
Av.			7.65		25.05				48.35

TABLE 5-b

Life history of Cylas formicarius Fabr. (Dry-season experiments)

LOT NO.	EGGS LAID	HATCHED	INCUBATION PERIOD	PUPATED	DURATION OF LARVAL STAGE	EMERGED	DURATION OF PUPAL STAGE	FIRST EGGS LAID	LENGTH OF LIFE CYCLE
	1924	1924	*days*	1924	*days*	1924	*days*	1924	*days*
1	20–III	26–III	6	18–IV	23	27–IV	9	4–V	45
2	20–III	26–III	6	16–IV	21	26–IV	10	3–V	44
3	20–III	26–III	6	19–IV	24	26–IV	7	6–V	47
4	22–III	28–III	6	22–IV	25	28–IV	6	7–V	46
5	22–III	28–III	6	22–IV	25	26–IV	4	4–V	43
6	22–III	30–III	8	20–IV	21	28–IV	8	5–V	44
7	22–III	28–III	6	21–IV	24	28–IV	7	5–V	44
8	22–III	28–III	6	22–IV	25	29–IV	7	7–V	46
9	1–IV	7–IV	6	28–IV	21	6–V	8	15–V	44
10	1–IV	7–IV	6	28–IV	21	4–V	6	10–V	39
11	1–IV	7–IV	6	1–V	24	7–V	6	14–V	43
12	1–IV	7–IV	6	29–IV	22	5–V	6	12–V	41
13	1–IV	7–IV	6	28–IV	21	6–V	8	14–V	43
14	1–IV	8–IV	7	28–IV	20	6–V	8	16–V	45
15	1–IV	7–IV	6	26–IV	19	4–V	8	11–V	40
16	1–IV	7–IV	6	28–IV	21	6–V	8	13–V	42
17	10–IV	16–IV	6	5–V	19	11–V	6	17–V	37
18	10–IV	16–IV	6	7–V	21	15–V	8	22–V	42
19	10–IV	16–IV	6	7–V	21	15–V	8	25–V	45
20	10–IV	16–IV	6	10–V	24	18–V	8	25–V	45
Min.			6		19		4		37
Max.			8		25		10		47
Av.			6.15		22.1		7.3		43.25

Egg (plate I, fig. 1).—Description: Length 0.65 millimeters; greatest diameter 0.46. Oval, attached end smaller than free end. Newly laid eggs white, transparent, soft; surface, rugose. Older eggs, especially those about to hatch, creamy, with a small brown, irregular, diffused speck, usually at free end; harder than newly laid eggs; chorion brittle, easily breaking on application of small amount of pressure with tip of dissecting needle.

Incubation: During the rainy season the eggs hatched in from 6 to 9 days after deposition; average incubation period 7.65 days (table 5-a). During the dry season, however, the incubation period varied from six to eight days with an average of 6.15 days (table 5-b). It is apparent, therefore, that in this particular stage of the insect the weather conditions exert a little influence. High temperatures undoubtedly tend to shorten the incubation period of the eggs.

Larval instars. Larval instars were determined by confining newly hatched larvæ, one in a vial, in which thin pieces of sweet potato roots had been introduced. These pieces of roots were changed daily without disturbing the larvæ. The presence of light brown head case in each vial served as an indication of molting. Sometimes it was observed that some of the larvæ, including the head, became very white, but head cases of the exuviæ could not be located. In the latter case, the larvæ were considered as having molted.

TABLE 6

Duration of each larval instar

CULTURE NUMBER	HATCHED	MOLTED	DURATION OF FIRST INSTAR	MOLTED	DURATION OF SECOND INSTAR	MOLTED	DURATION OF THIRD INSTAR	MOLTED	DURATION OF FOURTH INSTAR	PUPATED	DURATION OF FIFTH INSTAR
	1924	1924	*days*	1924	*days*	1924	*days*	1924	*days*	1924	*days*
1	29–XI	3–XII	4	7–XII	4	11–XII	4	16–XII	5	20–XII	4
2	29–XI	3–XII	4	7–XII	4	14–XII	7	19–XII	5	23–XII	4
3	29–XI	3–XII	4	9–XII	6	14–XII	5	21–XII	7	24–XII	3
4	30–XI	4–XII	4	9–XII	5	15–XII	6	19–XII	4	24–XII	5
5	3–XII	7–XII	4	12–XII	5	17–XII	5	24–XII	7	30–XII	6
6	3–XII	7–XII	4	12–XII	5	16–XII	4	22–XII	6	27–XII	5
7	3–XII	7–XII	4	12–XII	5	17–XII	5	23–XII	6	29–XII	6
8	4–XII	8–XII	4	12–XII	4	18–XII	6	23–XII	5	29–XII	6
9	4–XII	9–XII	5	13–XII	4	17–XII	6	22–XII	5	26–XII	4
10	4–XII	8–XII	4	14–XII	6	18–XII	4	22–XII	6	28–XII	6
11	4–XII	9–XII	5	13–XII	4	20–XII	7	26–XII	6	1-I-1925	6
12	5–XII	9–XII	4	14–XII	5	19–XII	5	25–XII	6	30–XII	5
Min.			4		4		4		4		3
Max.			5		6		7		7		6
Av.			4.16		4.75		5.33		5.66		5.00

First instar (plate I, fig. 2). Length of body 1.25 millimeters, width 0.505; length of head 0.30, width 0.25. Color white. Head dull yellowish brown.

Body subellipsoidal. Segments indistinctly differentiated. Slightly broader anteriorly than posteriorly. Sparsely beset throughout with minute hairs.

Head subhemispherical, with two connivent simple eyes on either side, posterior and close to bases of mandibles. Antennæ not in evidence. Region of mouth parts occupying about one-third head. Mandibles uniformly dark brown, occupying about one-half width of head. Maxillæ porrect, protruding anteriorly, depressed below level of mandibles, subequal in size to latter. Thorax subcylindrical. Metathorax subconfluent with first abdominal segment. Abdomen subconical, slightly incurved.

Duration of first instar varied from four to five days, with an average of 4.16 days (see table 6).

Second instar (plate I, fig. 3). Length of body 2.62 millimeters, width 0.62; length of head 0.54, width 0.42. General color white. Head ochraceous, shiny. Body subellipsoidal. Segments distinct. Sparsely beset throughout with minute hairs.

Head subhemispherical, a mesal longitudinal furrow, extending from occiput to frons. Mandibles dark brown. Antennæ not in evidence. One pair of connivent simple eyes, as in first instar. Length of thorax about one-fifth and width one and one-half times total length of body; thoracic segments subequal in length and in width.

Abdomen subconical; surface rugose. Nine distinct abdominal segments. Segment I subequal to any of thoracic segments in length and in width; II to VII subequal in width to one another, slightly narrower than I; VIII two-thirds as wide as any of the foregoing; IX slightly less than one-half as wide as VIII; II about one and one-half times as long as I; III about twice as long as I; IV to VI subequal in length to II; VII subequal in length to III; length of VIII about one-half its width; IX subconical, with length about one-half width.

Duration of second instar varied from four to six days, with an average of 4.75 (see table 6).

Third instar (plate I, fig. 4). Length of body 4.5 millimeters, width 0.94; length of head 0.68, width 0.61. General color white. Head shiny yellowish brown. Body soft, elongately subcylindrical, slender. Segments distinct, more or less similar in form and structure. Sparsely beset throughout with minute hairs.

Head subhemispherical; mesal longitudinal furrow, as in second instar. Mandibles uniformly dark brown, closely set at base, occupying about one-half total width of head. Maxillæ porrect, located anteromesally with respect to mandibles and depressed below level of latter, occupying about one-half width of head. Two pairs of connivent simple eyes, as in first instar. Antennæ not in evidence. Length of thorax about one-seventh total length of body. Prothorax about four-fifths total length of thorax; mesothorax about one and one-sixth as wide as prothorax; metathorax subequal in width to mesothorax; prothorax about one-third width; lengths of mesothorax and metathorax subequal to each other and to that of prothorax.

Abdomen subcylindrical; length about five-sixths total length of body; width about one-fifth length; surface rugose. Nine distinct segments. Segment I subequal to metathorax in length and in width; II to VI subequal in width to I; VII and VIII subequal in width to each other and slightly wider than any of body segments; IX about three-fourths as wide as VIII. Length of each of segments II to V about one-half their corresponding widths; length of VI about three-fourths its width; length of VII about five-sixths its width, length of VIII about three-fifths VII; length of IX subequal to VIII.

Duration of third instar varied from four to seven days, with an average of 5.33 days.

Fourth instar (plate I, fig. 5). Length of body 6.34 millimeters, width 1.31; length of head 0.72, width 0.64. General color creamy white. Head shiny, ochraceous. Body soft, elongate, distinctly arcuate. Segments distinct, prominent; surface wrinkled. Beset throughout with minute hairs.

Head subhemispherical; mesal longitudinal furrow, as in first instar. Mandibles prominent, uniformly dark brown, occupying about one-half total width of head. Maxillæ porrect, depressed below level of mandibles, occupying slightly more than one-half total width of head. Two pairs of connivent simple eyes, as in third instar. Antennæ not in evidence. Length of thorax about one-eighth total length of body; prothorax about one and one-sixth times as wide as head; mesothorax about one-seventh wider than prothorax; metathorax, which is the broadest thoracic segment, about one and one-eighth times as wide as mesothorax. Prothorax and mesothorax subequal in length to each other, about one and one-third as wide as prothorax. Metathorax about one and one-third as long as prothorax.

Abdomen subcylindrical, occupying about five-sixths total length of body. Nine distinct abdominal segments. Segments I to V subequal in length to one another and to metathorax; VI and VII subequal in width to each other, each about one and one-third times as wide as metathorax; VIII about four-fifths as wide as VII; IX about two-thirds as wide as VIII. I, the shortest abdominal segment, subequal in length to metathorax; length of each of segments II to VII about one and one-third times that of I; VIII subequal in length to I; IX about four-fifths as long as VIII.

Duration of fourth instar varied from four to seven days, with an average of 5.66 days.

Fifth instar (plate I, fig. 6 and 7). Length of body 5.25 millimeters, width 1.69; length of head 0.83, width 0.66. General color creamy white. Head ochraceous, shiny. Body soft, elongately subovoid; broadly arcuate ventrally; segments distinct, similar to those of fourth instar in general characters; uniformly and sparsely beset with minute hairs.

Head subhemispherical; mesal longitudinal furrow, as in fourth instar. Surface of epicranium rugose, sparsely and irregularly beset with minute hairs. Eyes and antennæ obsolete. Frons subtriangular, occupying about one-third total anterior area of head, describing an angle posteriorly, the apex of which meets median furrow about halfway from vertex to bases of mandibles. Clypeus broadly subreniform, emarginate anteriorly; subequal in lateral dimension to width of mandibles; length about two-thirds width; surface rugose, no hairs in evidence. Labrum depressed beneath level of clypeus and mandibles; semicircular; rounded off at anterior margin, densely beset with minute hairs, slightly narrower than clypeus; length about two-thirds width. Mandibles dark brown apically, gradually becoming lighter brown basally; subtriangular from anterior aspect; width at base about one-fourth that of head; length one and one-third times width; about as far apart basally as approximately one-fourth width of each. Maxillæ subequal to mandibles in width and in length, porrect, situated beneath mandibles, surface rugose, irregularly and sparsely beset with minute hairs; palpi three-segmented, subtriangular; about one-half total length of maxilla; segments subequal in length to one another; segment I about one-half total width of maxillæ; II, about three-fourths width of I; III, about one-half width of II; palpifer subtrapezoidal, about twice that of palpi in width; length about one-half width; cardo and stipes indistinctly differentiated; lacinia subtriangular, beset entally with lacinial bristles which are subequal in length to palpal segments II plus III.

Thorax irregularly subconical, attenuate anteriorly; about one-fourth as long as entire body; surface rugose, irregularly wavy in outline. Prothorax attenuate anteriorly, about two-thirds as wide as largest diameter of body, about one-half as long as wide; mesothorax subcylindrical, about two-thirds as long and one and one-third times as wide as prothorax, slightly attenuate anteriorly; metathorax subcylindrical, subequal in length to mesothorax, about one and one-half times as wide as prothorax. Legs not in evidence.

Abdomen about four-sixths as long as entire body; ten distinct abdominal segments; segments I to VII subcylindrical; surface rugose, irregularly wavy in outline; segment I one-half as long as and subequal in width to metathorax; II to VI, subequal in length and in width to metathorax; VII, subequal in length and about three-fourths as wide as metathorax; VIII, roundly attenuate posteriorly, slightly more than one-half as long and about four-fifths as wide as VII; IX, roundly attenuate posteriorly, about three-fourths as wide as VIII, length about one-fourth width; apparent segment X subhemispherical, attenuate caudally, about two-fifths as wide as IX; length

about one-half width; anal opening minute, located at extreme caudal end of X; suranal plate broadly suboval, irregular in outline, slightly less than one-half as long as abdominal segment X, width about twice length, surface rugose, no hair in evidence; paranal lobes much reduced; infraanal lobe broadly subreniform, about one-half as long as X, width about twice length, surface rugose, no hair in evidence.

Paired spiracles present on ventral surface of thorax between pro- and mesothoraces, absent between meso- and metathoraces, and present paraventrally on each of abdominal sternites I to VIII, situated as far apart from each other as about one-half greatest width of body. Diameter of each about one-fiftieth greatest width of body; subcircular, guarded at opening by a pair of connivent elongately subreniform processes which protrude over level of body wall.

Duration of fifth instar varied from three to six days with an average of five days (see table 6).

After hatching, the larva begins to eat its way deep into the tissues of the root. The first-instar larva, on account of its small size, eats but a small quantity of food and thus produces a correspondingly small bore. The size of the tunnel increases progressively with each succeeding instar, so that by the time the fifth, or last, larval instar is reached, the interior of the infested sweet potato root is tunneled in all directions. The tunnels are more or less irregular in shape and in size, and may meet each other several times. In general, however, each tunnel, representing the work of a single larva is smaller near the opening and grows larger and larger in diameter in correlation with the growth of the insect after the successive ecdyses. The larvæ, as they progress in their tunnels, leave behind them in their burrows a mass of excrementitious matter. In stored roots, the larvæ are never found coming out of the tuber.

Toward the end of the fifth instar, the larva becomes less active. Upon opening an infested root at this stage, it will be found that the burrow containing the larva is much enlarged, with the surface relatively smooth. In this cavity pupation takes place. The pupating larva ceases to feed, and exhibits a somewhat somnolent attitude.

Pupa (plate II, fig. 8, 9 and 10). Length of body 5 millimeters; width 2; subellipsoidal. General color white. Body and appendages soft. Sparsely and irregularly beset with moderately long hairs, which are concolorous with body.

Snout about two-fifths total length of body; four times as long as wide; directed anteroposteriorly, extending to middle of metasternum, pressed closely against thoracic sterna. Antennæ, mouth parts, wings, and legs subprominent; joints indistinct. Mandibles prominent, light brown, more strongly chitinized than rest of body. Antennæ directed anterodorsally and pressed entally against lateroventral surface of prothorax and entocephalic margin of forelegs, inserted at approximately apical third of snout; club and funicle not clearly differentiated; no hair in evidence. Larger diameter of eyes about one-sixth total length of snout, not prominent, represented by two suboval areas located at about basal third of snout.

Prothorax compressed anteroposteriorly, subquadrangular in dorsal outline, about four-fifths as wide as head, three times as wide as long. Mesothorax about one and one-half to twice as long as prothorax, width twice length, subequal in shape to prothorax. Metathorax three times as long as prothorax, width subequal to length, subtriangular in dorsal outline, with a mesal longitudinal furrow. Fore and hind wings subequal in shape and in structure; elongately subellipsoidal, white, sack-like, soft; surface rugose. Hind wings slightly smaller than fore wings.

Abdomen apparently eight-segmented; surface rugose, sparsely beset with minute hairs. Cerci curved dorsocaudally, pointed at apex; surface rugose, beset at base with minute hairs.

The pupal stage is spent inside the sweet potato root, in a relatively large cavity formed at the end of the larval tunnel. This cavity is hollowed out by the larva prior to pupation, suboval, and spacious, so that the pupa can wiggle freely when disturbed. The ental surface of this cavity is grey, smooth, and dry. Only one pupa in all cases may be found to occupy a cavity.

When disturbed, the pupa executes with the posterior half of its body, a jerking motion, either sidewise or in a rotary manner. When the pupa is removed from the case it keeps on moving for some time. On exposure even for

a few minutes the pupa turns dull brown. Pupæ which were removed from the pupal cavities and kept in small wide-mouthed bottles, continued to live and emerged as adults in from four to six days after pupation. The adults thus obtained, however, were weak and most of them died soon after emergence. Experiments were also conducted on the normal duration of the pupal stage *in situ*. Tubers were split open just enough to make possible observations on the insect. Tables 5-a and 5-b show the duration of the pupal stage under such conditions. It varied from 4 to 10 days, with an average of 7.6 days, thus representing a period considerably longer than in the case of pupæ removed from the burrows.

Adults. Male (plate II, fig. 11 and 12). Length of body 6.34 millimeters; length of head 1.88; length of antennæ 2.06; length of elytra 2.72, width 1.13; length of hind wings 4.5, width 1.56; total length of thorax 2.87; length of prothorax 1.25; length of abdomen 1.59. Body elongately subellipsoidal. General color dark metallic blue. Metasterna, elytra, and abdominal sternites unicolorous with body. Head black. Antennæ, prothorax, mesothorax, and legs brick red. Metanota and abdominal tergites colorless, soft, in contrast with other parts of body, which are heavily chitinized.

Head rugose, more finely so basally, elongate, about three times as long as wide. Rostrum slightly curved anteroventrally; a lateral, elongate furrow, or scrobe, directed posteroventrally on either side behind mouth parts, about one-third distance between eyes and tip of snout, these furrows representing cavities for reception of antennæ while insect is eating, resting or feigning death. Surface of head subconfluent with that of prothorax, the line of demarcation being evident only from abrupt transition from black color of former to brick-red of latter. Area occupied by mouth parts about three-fourths total width of snout. Mandibles (plate III, fig. 15) situated outermost with respect to other mouth parts, prominent, distinctly pointed at apex, occupying about one-half width of snout; apical tooth larger than subapical, elongate, curved anteromesally, heavily chitinized, dark brown, lighter basally, surface smooth, irregularly subtriangular in cross-section, subapical tooth subequal in shape and structure to apical, less strongly curved than latter. Mandibles equidistant from each other as each is to lateral margin of snout. Maxillæ (plate III, fig. 16) less prominent and set closer together than mandibles, located posteroventrally between latter and occupying slightly over one-half entire width of snout. Maxillary palpi subtriangular, three-jointed, surface rugose, beset with few hairs, segment III subequal in length to I and II, twice as long as wide, cross-sectional diameter about one-half that of II and one-third that of I. Palpifer resembling segments of maxillary palpi in shape and in structure, about one and one-half times as wide as, and subequal in length to, segment I of latter. Stipes about twice size of palpifer, subtriangular, rugose. Cardo subequal to segments II plus III of maxillary palpi in size and in structure, elongately subtriangular, with rounded-off posterior margin which exactly fits into socket-like anterior depression on either side of peduncle of submentum. Lacinia subtriangular, subequal in length and in width to maxillary palpi, ectal surface thickly beset with bristles; latter longer at base than at other parts of lacinia, entally, numerous pointed teeth, which are shorter but broader at base than bristles. Subgalea subtriangular, beset with a few hairs in the midposterior margin, subequal to palpifer in size. Mentum situated posterior to maxillæ in center of buccal region, subcircular, with socket-like anterior depressions on either side, similar to those of submentum, for reception of palpi, width about one-third that of snout. Labial palpi two-jointed, much reduced in size, being slightly smaller than segment III of maxillary palpi. Submentum about one-fourth width of snout at anterior margin, gradually becoming narrower posteriorly until it forms a waist between antennal scrobes. Peduncle of submentum distinctly depressed at anterior margin in which mentum rests, about one-half width of snout, about four times wider than long. Genæ, as well as mentum and submentum, rugose, with regularly arranged very minute hairs. Antennæ (plate III, fig. 17) ten-segmented; divided into scape, or basal segment; funicle, comprising the next eight segments; and the club, or terminal segment. Scape abruptly obconical, attenuate and broadly curved apically, about one-tenth total length of antenna; subequal in cross-sectional diameter to segment I of funicle; surface reticulate, beset proximally with a few minute hairs. Funicle about one-fourth total length of antennæ, segments I and VIII subequal to each other in length and in width, slightly longer than any of II to VII; latter segments subequal in length and width. Club apparently a solid piece, about seven times as long as wide, occupying nearly two-thirds total length of antennæ. Surface rough, entirely covered with hairs. Each antennal segment intercalated basally into adjoining proximal segment. Antennal scrobes each an elongate socket-like structure at ventral surface of rostrum, situated midway between base and apex of latter, sparsely beset with hairs at edges; width of scrobe about one-fourth that of snout; set apart at a distance of approximately one and one-half times width of socket. Eyes metallic dark-brown, prominent, occupying about one-sixth total length of head, hemispherical, protruding very markedly over surface of head; distance between eyes about one-third width of head, wider apart posteriorly than anteriorly.

Prothorax elongately subellipsoidal with dorsolateral depression on posterior third. Cross-sectional diameter of anterior two-thirds about one and one-fifth times as much as that of posterior third. Dorsal margin about one and one-third times as long as ventral margin. Surface finely punctate, beset with microscopic hairs. Two ventral subcircular foveæ for reception of pro-

thoracic coxæ. Distance of each of former from margin of prothorax about one-half diameter of fovea; distance between foveæ about one-tenth their diameter, equidistant from caudal and cephalic margins of prosternum. Prothoracic coxæ subconical, rounded at both ends, conspicuously larger basally, length approximately one-third thickness of prothorax, about one and one-half times as long as largest cross-sectional diameter. Trochanter subtriangular, length about one-third that of coxa, width subequal to length. Femur vaguely subellipsoidal, slightly attenuate and produced proximally, length about eight times that of trochanter, width about one-fourth length. Tibia subequal in length to femur, width about one-tenth length, proximal end about two-thirds that of distal end in cross-sectional diameter; markedly incurved and intercalated into proximal end of femur. Surface rugose, beset with moderately long hairs; bristles present more or less regularly on ental surface, more densely so around subdistal margin. Tarsi four-segmented, about three-fourths length of tibia, width approximately one-sixth length; segments I, II and III reduced; I, slightly less than one-third total length of tarsus, width about one-third length; II, slightly shorter than, but subequal in width to, I; III, suboval, bilobed distally; slightly shorter than II, width about two-thirds length; IV, elongate, incurved subapically, proximal end about one-third II in width, slightly smaller than distal end in cross-sectional diameter, length slightly more than four times greatest diameter; apically, a pair of dark brown, sharply pointed, incurved claws; surface of all tarsal segments rugose, beset with numerous hairs, more densely so distally; moderately long bristles present on ental surface of I and around subdistal end of II.

Mesothorax subconical, attenuate anteriorly, a pair of lateroventral depressions on anterior fifth; surface rugose, sparsely beset with minute hairs, more densely so anteriorly. Legs set near caudal margin; as distant apart as diameter of proximal end of coxa, which is about one-third as wide as mesothorax, suboval, surface rugose; proximal end sinuous; distal end slightly incurved, width about two-fifths that of proximal end; sparsely beset with microscopic hairs. Trochanter subconical; distal end about one-third that of coxa in cross-sectional diameter; width of proximal end about one-half that of distal end; length about two-thirds diameter of distal end; surface rugose, sparsely beset with minute hairs, similar to coxæ. Femur elongate, slightly tapering distally; length about four times width; proximal half subcylindrical, subequal to trochanter in cross-sectional diameter; distal half abruptly incrassate, twice that of proximal half in cross-sectional diameter; distal end rounded, slightly incurved; surface rugose, uniformly beset with minute hairs, those at proximal half slightly longer than those at distal half. Tibia subequal to femur in length; width about one-eighth length, proximal end conspicuously incurved, width slightly over one-half that of distal end; surface beset with moderately long hairs; bristles present at more or less regular intervals on ental surface, denser around subdistal margin. Tarsus four-segmented; subequal to tibia in length; segments I and II subconical; I, slightly less than one-third entire length of tarsus, width about one-third length, proximal end about one-half that of distal end; surface rugose beset with moderately long hairs; bristles present on ental surface and around sub-distal margin at more or less regular intervals; length of II about one-fourth that of entire tarsus, width slightly less than one-half length, proximal end about two-thirds distal end; surface rugose beset regularly with moderately long hairs; bristles present around sub-distal margin at more or less regular intervals; III, bilobed, one-fourth total length of tarsus, width subequal to length; IV, about one-half total length of tarsus; width about one-seventh length; a pair of claws similar to those of prothoracic legs in structure and position; moderately long hairs present on all tarsal segments; conspicuously more minute at ental surfaces of segments I, II, and III.

Metathorax subcylindrical, surface characters similar to those of mesothorax. Hind wings located at anterolateral margin of metathorax. Legs attached at subcaudal margin of metasternum; distance of each from lateral margin of latter about one-third width of metathorax. Coxa subconical, about one-seventh as long as metathorax; surface structures sub-equal to those of mesothoracic coxæ; cross-sectional diameter of proximal end about four times that of distal end. Trochanter subconical, about one-half as long as coxa, width about twice length; surface rugose, with few minute hairs; proximal end about two-thirds distal end in cross-sectional diameter. Femur subequal to that of mesothorax in shape and texture; greatest cross-sectional diameter about three times that of trochanter; length about five times width. Tibia elongate, proximal end markedly incurved and intercalated into distal end of femur; width subequal to that of trochanter; length about nine times width; moderately long hairs present at irregular intervals; bristles present on ental surface at irregular intervals, more densely so around subdistal margin. Tarsus subequal to tibia in length; segment I about one-third entire length of tarsus, width about one-third length, distal end about two times proximal end in cross-sectional diameter; surface rugose, beset with moderately long hairs, bristles at irregular intervals on ental surface; II about one-fourth tarsus in length, width about one-half length proximal end subequal to distal end in cross-sectional diameter, few bristles at subdistal margin; III bilobed distally, length about same as that of II, width subequal to length, surface rugose beset with moderately long hairs, no bristles in evidence; IV markedly curved entally, bearing at its distal end a pair of claws which are similar in general characters to those of prothoracic tarsus, occupying more than one-third entire length of tarsus, width about one-seventh length.

Elytron (plate III, fig. 19) elongately subellipsoidal, convex, strongly chitinized; microscopic punctures in about 22 more or less regularly arranged rows, which are subparallel to one another and to costal margin of elytron; distance between rows subequal. Hind wing (plate III, fig. 20) subtrapezoidal, hyaline; veins light brown; humeral angle about 45°; anal angle rounded, about 120°; apex about 80°, rounded, slightly directed towards outer margin; costal margin slightly depressed at proximal half; outer margin markedly outcurved, occupying about three-fourths

entire length of wings, apparently consisting of two subequal margins, proximal half subparallel to costal margin; inner margin slightly incurved, about one-fourth as long as costal margin; C extending along proximal fifth of wing, close to costal margin, subparallel to latter, gradually attenuate distally; Sc unbranched, extending along proximal two-fifths of wing, attenuate distally, proximal third describing an angle of about 15° with C, middle third directed toward costal margin and meeting distal end of C, describing thus an interior angle subequal to that formed by proximal end, distal third directed toward apex, describing an angle of about 150° with middle third; R unbranched, broadly curved toward costal margin, meeting latter subapically, terminating proximally at about basal third of wing, distance from costal margin about one-third width of wing; M unbranched, coextensive proximally with R, extending to mid-distal half of outer margin, slightly curved toward costal margin; Cu unbranched, markedly bent at distal third toward middle of outer margin, proximal two-thirds larger than distal third, directed entoapically; A subequal in length and subparallel to inner margin, oriented with respect to latter in the same relative position as C is to costal margin; no branches in any of veins in evidence.

Abdomen subconical, five-segmented; segment I about one-half total length of abdomen, width about one and one-third times length; II about one-sixth as long as I, width about five times length; III subequal to II in length, width about four times length; IV and V subequal to each other and twice that of III in length; width of IV slightly less than twice length; V, or pygidium, exposed beyond apices of elytra, about one and one-half times as wide as long, hemispherical, surface reticulate, covered with minute hairs.

Genitalia (plate III, fig. 21). Tegmen semicircular from ventral aspect, slightly more than one-half length of abdominal segment IV, width about one and one-third times length, surface rugose, irregularly beset with microscopic hairs, distal half beyond distal margin of IV. Tegminal strut subtriangular from ventral aspect, situated at distal fourth of IV, attenuate distally, with rounded-off distal margin, about one-fifteenth length of IV, width subequal to length. Strongly chitinized paired spiculum situated at middle of segment V, connected by a Y-shaped strand of same degree of chitinization, which extends anteriorly to middle of II. Flagellum extending from distal fourth of IV to middle of I, slender, not uniform in width throughout. Median strut sickle-shaped, with ental surface toward lateral margins of abdomen, situated at middle of III, attenuate distally, about one-half as long as abdominal segment III, greatest width about one-third length, surface rugose.

Female (plate II, fig. 13 and 14). Similar to male in general characters of body, slightly shorter than male, as may be readily seen by a comparison of their respective measurements. Differences are also well marked in antennal characters.

Length of body 5.86 millimeters; length of head 1.81; length of antennæ 1.49; length of elytra 2.81, width 1.13; length of hind wings 4.31, width 1.31; total length of thorax 2.81; length of prothorax 1.14; length of abdomen 1.59.

Antennæ (plate III, fig. 18) ten-segmented, as in male. Scape, vaguely S-shaped, occupying about one-fifth total length of antennæ; greatest width about one-third length, surface rugose, hairless, gradually incrassate distally, abruptly spherical basally. Funicle eight segmented, occupying about two-fifths total length of antenna; greatest width about one-fifth length; segments subequal in length; abruptly obconical, as in male, gradually increasing in diameter apically; surface rugose, sparsely and irregularly beset with moderately long hairs. Club abruptly subfusiform; surface rugose, with hairs of general characters similar to those of funicle, more thickly beset than latter, subequal to funicle in length; width slightly more than one-third length.

Ovipositor (plate III, fig 22) consisting of a pair of elongately subconical, two segmented, processes, abruptly attenuate distally, slightly longer than segment V of abdomen; width of each slightly more than one-third length; distal segment minute, about one-ninth total length of basal segment, beset at distal margin with moderately long hairs.

Behavior of adults: The adult is a very active insect when not disturbed. When walking, it moves fast with the head carried at an angle slightly above the level of the body, and the antennæ outstretched laterally describing an angle of about 45° with the head. When touched, the insect becomes motionless, with the antennæ directed posteroventrally. When disturbed further, it drops to the ground, lies on its side or back, feigning death. In this condition the legs are directed ventrally with the metathoracic pair slightly pointed toward the posterior end of the body. The insect remains in this position for quite a long time and, when finally left alone, soon regains its former activity by first moving the head sidewise accompanied by the vibration of the antennæ.

Newly emerged individuals stay within the tunnels in the roots for some time. The adults are usually found on the surface of the sweet potato roots. They are also seen clinging on the stems above the ground. They are usually in a resting condition, with the snout slightly flexed ventrally, and the antennæ in the same position as when the insect is feigning death. The knees are slightly

above, or in the same level, with the dorsal surface of the body. Sometimes the knees of the hind pair are lower than the level of the elytra. While in this position, the insect is usually feeding.

The insect is not seen flying in day time. It is, however, observed to fly at night; sometimes to light, in company with other night-flying insects. At sunset many of these weevils, mostly males, may be seen on sweet potato leaves and stems. They are very active.

During copulation, the insects may remain either stationary on a fixed spot or walk about. The male is carried on top of the female at an angle of about 45°. The snout of the male is slightly deflected toward that of the female; the antennæ are outstretched and in continuous vibration. The fore and middle legs of the male hold fast to the thorax of the female in the region between the bases of the fore and middle legs of the latter. The male's hind legs, with the tarsi directed posteroventrally, are fastened at the subcaudal part of the abdomen of the female.

When walking, the female carries the male on her back. Oftentimes the male cannot maintain a fixed hold on the body of the female and falls a number of times. After several unsuccessful attempts at regaining his position, the male usually gives up his pursuit.

Duration of adult stage: The adult stage varies from 63 to 120 days. On the average, males show greater longevity than females. As may be seen from table 7-a, the duration of adult life of males varied from 63 to 120 days with an average of 97.16 days. Table 7-b shows the duration of adult life of females to vary from 81 to 107 days with an average of 96.12 days.

TABLE 7-a

Longevity of adult males

CULTURE	DATE EMERGED	DATE DIED	LONGEVITY
	1924	1924	*days*
1	10–I	22–III	72
2	10–I	16–IV	97
3	10–I	26–IV	107
4	10–I	9–V	120
5	10–I	16–IV	97
6	10–I	28–III	78
7	10–I	13–III	63
8	10–I	6–V	117
9	11–I	13–IV	93
10	11–I	15–IV	95
11	12–I	5–IV	84
12	12–I	4–V	113
13	12–I	27–IV	106
14	14–I	28–IV	105
15	14–I	24–IV	101
16	14–I	16–IV	93
17	14–I	28–IV	105
18	18–IV	6–VIII	110
19	18–IV	24–VII	97
20	18–IV	19–VII	92
21	18–IV	28–VII	101
22	18–IV	11–VIII	115
23	20–IV	3–VII	74
24	21–IV	8–VIII	109
25	24–IV	18–VII	85
Minimum	———	———	63
Maximum	———	———	120
Average	———	———	97.16

TABLE 7-b

Longevity of adult females

CULTURE	DATE EMERGED	DATE DIED	LONGEVITY
	1924	1924	*days*
1	10–I	18–IV	99
2	11–I	17–IV	97
3	11–I	20–IV	100
4	11–I	22–IV	102
5	12–I	22–IV	101
6	12–I	12–IV	91
7	12–I	9–IV	88
8	12–I	20–IV	99
9	12–I	15–IV	94
10	12–I	22–IV	101
11	13–I	17–IV	95
12	13–I	23–IV	101
13	13–I	14–IV	92
14	13–I	17–IV	95
15	14–I	24–IV	101
16	18–IV	16–VII	89
17	18–IV	25–VII	98
18	19–IV	25–VII	97
19	19–IV	21–VII	93
20	19–IV	9–VII	81
21	19–IV	4–VIII	107
22	19–IV	29–VII	101
23	20–IV	1–VIII	103
24	20–IV	13–VII	84
25	21–IV	24–VII	94
Minimum	———	———	81
Maximum	———	———	107
Average	———	———	96.12

Number of generations during the year

The work was begun on October 27, 1923. Virgin females were fertilized and placed in separate battery jars together with the necessary food and soil. The insects were removed after the first oviposition. The eggs were left to incubate in the containing roots. Precaution was taken in the meantime to prevent accidental contamination from without, by covering the tops of the jars with cheese cloth. The first adult female which emerged from each lot was isolated, mated, and allowed to oviposit on fresh roots. Successive generations were raised in this manner from an original parental stock. The work was carried through to November, 1924. This work was not extensive enough to warrant very definite conclusions, but on the basis of one culture, indications are that there are nine generations during the year, distributed, in this particular case as follows:

First generation—October 27, 1923, to December 11, 1923.
Second generation—December 11, 1923, to January 28, 1924.
Third generation—January 28, 1924, to March 15, 1924.
Fourth generation—March 15, 1924, to April 24, 1924.
Fifth generation—April 24, 1924, to June 4, 1924.
Sixth generation—June 4, 1924, to July 17, 1924.
Seventh generation—July 17, 1924, to September 5, 1924.
Eighth generation—September 5, 1924, to October 13, 1924.
Ninth generation—October 13, 1924, to November 27, 1924.

Host plants

This subject was not thoroughly investigated in the present work, hence, no definite conclusions can be drawn. Experimentally, the insect was induced to feed and lay eggs in the laboratory on the stem of aurora, or morning glory, *Ipomœa cairica* (Linn.) Sweet.[4] In nature, however, this plant was never found to be infested by *Cylas*. The commoner weeds of sweet potato fields were examined also and were found absolutely free from attack of this pest.

Relation of Cylas formicarius to the sweet potato

In all of its stages the insect is dependent on the sweet potato or perhaps related species for subsistence. The adult bores into either the stem or the root but no immediate serious damage was observed to follow the attack. The greatest injury is evidently produced by the larvæ. The following experiments were conducted for the purpose of determining this phase of the subject.

Three large glass jars were thoroughly cleaned, and about five roots, which had been washed, were introduced, together with male adults. The insects were prevented from escaping by covering the mouths of the jars with cheese cloth. The insects were allowed to feed on the roots for at least one and one-half months, at the end of which time the plant materials were examined. It was found that the surfaces of the roots bore small punctures resulting from the feeding of the adult males, but in almost all cases neither discoloration nor foul odor was noted. With the exception of the holes, the roots were practically sound.

In connection with the experiments on the number of eggs laid daily by each female, reported in previous paragraphs, observations were also conducted as to the degree of injury resulting from feeding and oviposition by the females. In all cases observed, no damage resulted on the roots, other than the formation of egg cavities and the punctures resulting from feeding. As in the case of the holes produced by the feeding of the males, the wound caused by the female, either as a result of feeding or oviposition, is not accompanied by discoloration of the surrounding tissues of the roots.

The larval stage causes the greatest amount of damage to the plant. The feeding activities are confined to fixed areas and, moreover, the insect is most voracious at this stage. It feeds by tunneling through the protected inner tissues or, in the case of roots covered by soil, even through the epidermal and cortical layers. Infestation occurs either in the field or in storage. Considering the voracity of the larvæ, their habit of confinement in one infested root during the entire larval stage (for they do not migrate from one root to another), and the length of the larval stage, which ranges from 19 to 27 days, it is not to be wondered at that roots harboring the larvæ, in a large majority of cases, become almost completely riddled with tunnels. The familiar discoloration of the root tissues surrounding the tunnels and the accompanying disagreeable odor and no less disagreeable taste are apparently not a direct result of the work of the larvæ, but are rather due to secondary agencies, presumably bacteria, fungi or other microorganisms. This phase of the subject needs a more thorough investigation. This stand is taken in connection with the relation of the larva and the host in view of the fact that there are cases wherein tissues surrounding wounds are otherwise perfectly sound, which leads to the inference that in all probability the

[4]Determination by Dr. Eduardo Quisumbing, of the Department of Plant Physiology.

micro-organisms which cause the characteristic symptoms had not yet gained entrance. Experimentally, the matter has been roughly determined further by simulating the larval tunnels in previously cleaned roots by means of sterilized needles. Discoloration and the accompanying odor and taste did not appear in the tissues. As an additional step, a number of the roots so treated were artificially inoculated from the roots which showed these characteristics, and invariably the symptoms developed; the checks remained normal.

From the foregoing discussion, it will be seen that in the degree of damage done the various stages of the weevil rank in the following order: 1, larvæ; 2, adult female; 3, adult male; the injury caused by the larvæ is preponderantly greater than that of any one of the others. The adults on emergence from the pupal case contribute to the damage caused by the larvæ by tunneling to the surface of the root in order to effect their escape.

In regard to possibility of seasonal conditions affecting the degree of infestation, observations were observed mainly on the variety Samar Big Yellow. The patch covered an area of approximately forty square meters, situated on the side of the road running northwest of the Entomology-Pathology Building, College of Agriculture. Weevils were observed in abundance on this patch, particularly at about twilight, and the roots, as well as the stems, were badly infested throughout the year. In each of the twelve months, the inside of the roots harbored numerous larvæ and pupæ as well as freshly emerged adults. Occasional observations on other sweet potato patches near the College Campus revealed the same conditions.

It is evident that seasons of the year, at least in the Philippines, have no appreciable effect on the degree of intensity of infestation. Even in temperate or subtemperate countries where relatively greater seasonal extremes exist, as in southern United States, this insect, as witness the observation of Reinhard (1923), does not pass through a definite period of hibernation, but is found actively feeding on stored roots even in continuous cold weather.

A preliminary survey made on a number of different varieties of sweet potato both on the College Farm and in the adjoining regions, seems to point to the conclusion that no one variety can be singled out as relatively more immune to the attack of *Cylas formicarius* than the others. Possibly, resistant varieties as means of control will not be effective in connection with this pest.

Incidentally, it may be mentioned at this juncture that work on insecticides which is being undertaken in connection with the present investigations has not progressed far enough to warrant any statement at this time as to their value in either field plantings or roots in storage.

B. CONTROL

It has been pointed out in the foregoing paragraphs that there is as yet no local variety of sweet potato that is definitely known to exhibit any degree of resistance to the attack of *Cylas formicarius*. The possibility of control as a result of planting resistant varieties cannot then be considered in the light of our present knowledge of the subject.

The present investigations have barely covered the subject of natural enemies. It is planned to have this phase treated in a later report. Two species of Braconidæ were reared by Mr. A. G. Toquero, in Manila, during the year 1919

from *Cylas turcipennis* Bohm, which is probably an incorrect identification for *C. formicarius.* The parasites are *Microbracon cylasovorus* Rohwer and *Bassus cylasovorus* Rohwer both of which were described as new species in the *Philippine Journal of Science* (1923). It is interesting to note that apparently neither natural enemies nor seasonal conditions are very effective in holding the pest in check, except perhaps in sporadic cases. On the College Campus and vicinity, destruction caused by this insect has not perceptibly abated at any time during the period covered by the present experiments, for the weevils and their immature forms are uniformly abundant throughout the year. In certain other pests of economic plants, certain periods during the year can be selected for planting so as to escape serious injury. No such recommendation can be made for the sweet potato in connection with *Cylas formicarius.*

Fumigation with carbon bisulphide has been tried in connection with infested roots in storage. The results so far have not been very encouraging. Although the adult weevils on the outside of the roots were killed, the larvæ in their burrows remained unaffected. Further tests are, however, being conducted with larger doses of this and other fumigants, and different types of inclosures are being used. It is expected that progress reports on this remaining part of the work will be published from time to time.

In the discussion in the first part of the present paper it was stated that the insect confines its attack on the roots and stems. This behavior points to the fact that to avoid carrying the insect to new sweet potato plantings by means of the planting stock, only the more succulent tops, which in the present work have never been found attacked by the pest, should be used in propagation.

Along with other cultural methods, rotation with other crops may be recommended. No other field crops are known to be attacked by this pest, so that from the standpoint of control of this particular species, almost any other commonly cultivated farm product should prove suitable in rotation.

SUMMARY OF CONCLUSIONS

1. The species on which the present work is based is *Cylas formicarius* Fabr. It is often confused with *C. turcipennis* Bohm. and has often been reported as such in Philippine entomological literature.

2. This weevil is of world-wide distribution; it has been reported from all countries in which the sweet potato is grown.

3. In the Philippines, sweet potatoes, both in the fields and in storage, are badly damaged by these weevils.

4. Eggs are laid in holes made by the female in older stems and roots. Only one egg is laid in each hole.

5. The female begins to lay eggs at from six to ten days after emergence.

6. The number of eggs laid daily by each female varies from zero to twelve, with an average of 3.06 eggs.

7. The total number of eggs laid by each female during her period of fecundity varies from 90 to 340, with an average of 256.03 eggs. Rate of daily production and length of adult life seem to be directly correlated with total number of eggs.

8. The period of fecundity lasts from 56 to 93 days, with an average of 81.83 days.

9. The female usually continues to lay eggs till close to the time of her death; in occasional instances, the end of the period of fecundity is survived by only nine days at most.

10. The incubation period of the egg varies from six to nine days, with an average of 7.56 days. Eggs hatch in shorter time during the dry season than during the rainy season.

11. The larvæ molt five times, the fifth marking the transition to the pupal stage.

12. The duration of the larval stage ranges from 19 to 27 days.

13. The duration of the different larval instars are as follows:

First instar, four to five days; average, 4.16 days
Second instar, four to six days; average, 4.75 days
Third instar, four to seven days; average, 5.33 days
Fourth instar, four to seven days; average, 5.66 days
Fifth instar, three to six days; average, 5.00 days.

14. The duration of the pupal stage ranges from four to ten days, with an average of 7.6 days.

15. The length of adult life ranges in males from 63 to 120 days, with an average of 100.88 days, and in females from 81 to 107, with an average of 96.01.

16. Descriptions of the egg, the larval instars, pupa and adults are given.

17. There are nine generations during the year.

18. With the exception of the adult stage, the whole life of the insect is spent inside the sweet potato root and stems. The adult stage is spent in the open.

19. The adult male causes a negligible amount of damage as a result of feeding, and the adult female just a little more as a result of feeding and oviposition. The actual injury is caused by the feeding activities of the larvæ.

20. Discoloration and the accompanying characteristic odor and taste in the affected roots are the result of secondary infection, possibly by certain microorganisms, and are not a direct result of the work of the larvæ. These characteristics have not been observed to follow the work of the adults.

21. The insect is destructive to the roots of sweet potato at all times of the year, so that apparently neither seasonal conditions nor natural enemies have a marked effect in keeping the pest in check.

22. No variety of sweet potato in the present work was found free from attack of the weevils. The use of resistant varieties as a means of control can not yet be recommended.

23. The insect was induced to feed in the laboratory on aurora, or morning glory, *Ipomœa cairica* (Linn.) Sweet. It has not, however, been found to feed on this plant under natural conditions.

24. The subject of natural enemies has not been thoroughly investigated in the present work. Other local workers have found certain parasites on this pest; two of these are Braconids; namely, *Microbracon cylasovorus* Rohwer and *Bassus cylasovorus* Rohwer.

25. The weevils were not observed to breed or feed on young shoots of sweet potato. The use of this part as planting stock, in preference to the older stems and roots, is advocated as a preventive measure against fresh infestation of new areas.

26. Proper disposal of sweet potato roots and stems after each harvest will help reduce the insects by starving them.

27. Crop rotation is also advocated. *Cylas formicarius* has not been found to attack any field crops other than sweet potato, so there is a wide range for choice in rotation.

28. Experiments on the control of the pest in sweet potato roots in storage by fumigation with carbon bisulphide have not given very encouraging results.

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ILLUSTRATIONS

PLATE I

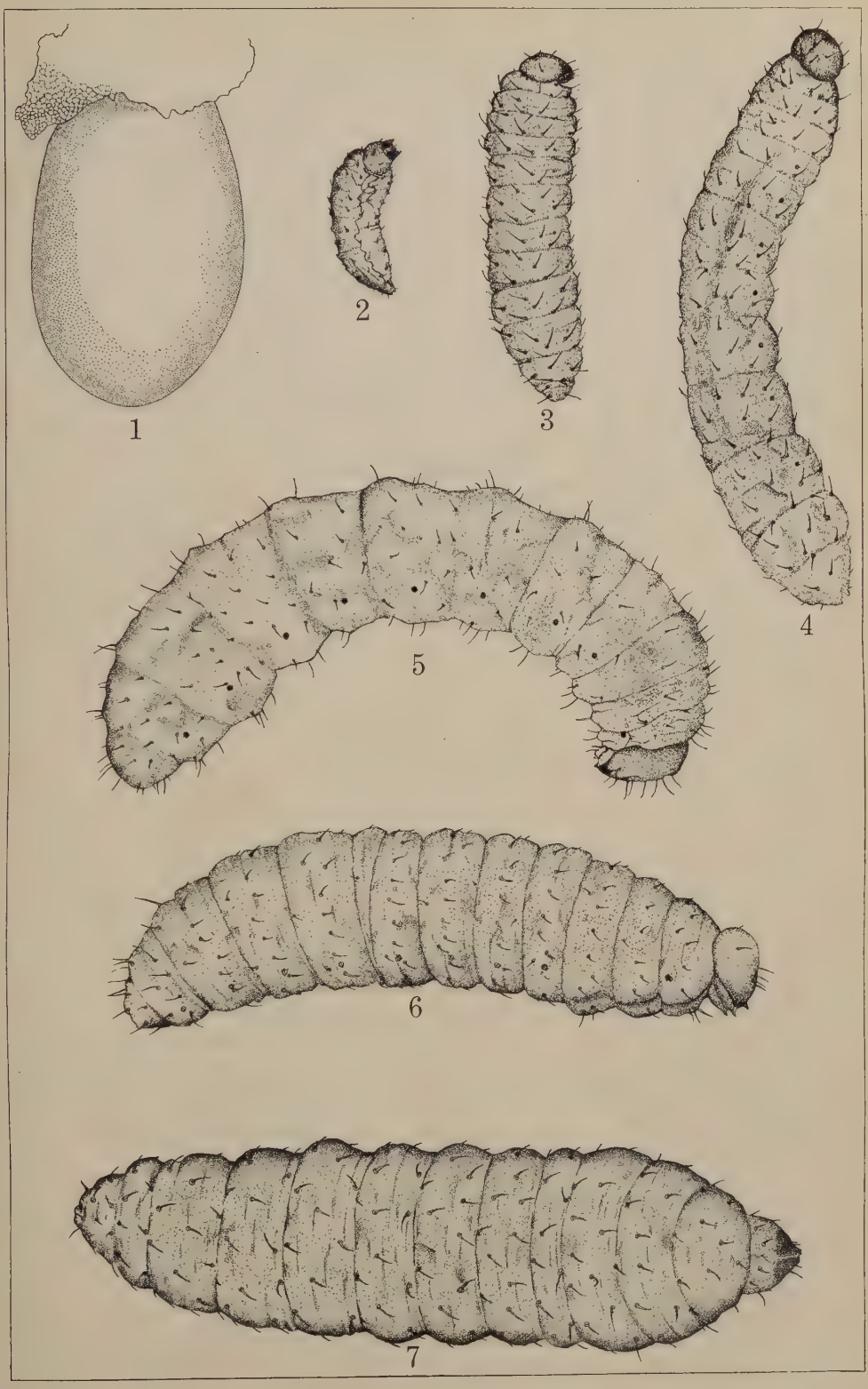
Figure 1. Egg ×88
2. Larva, first instar, lateral view ×10.5
3. The same, second instar, lateral view ×10.5
4. The same, third instar, lateral view ×10.5
5. The same, fourth instar, lateral view ×10.5
6. The same, fifth instar, lateral view ×10.5
7. The same, fifth instar, ventral view ×10.5

PLATE II

8. Pupa, dorsal view ×10
9. The same, lateral view ×10
10. The same, ventral view ×10
11. Adult, male, lateral view ×10.5
12. The same, ventral view ×10.5
13. Adult, female, lateral view ×10.5
14. The same, ventral view ×10.5

PLATE III

15. Left mandible adult male, ental aspect ×360
16. Right maxilla of adult male, ental aspect ×88
17. Right antenna of male ×48
18. Right antenna of female ×48
19. Right elytron of male ×18.25
20. Right hind wing of male ×10.5
21. Male genitalia, ventral view ×48
22. Genitalia, sinistral aspect ×48



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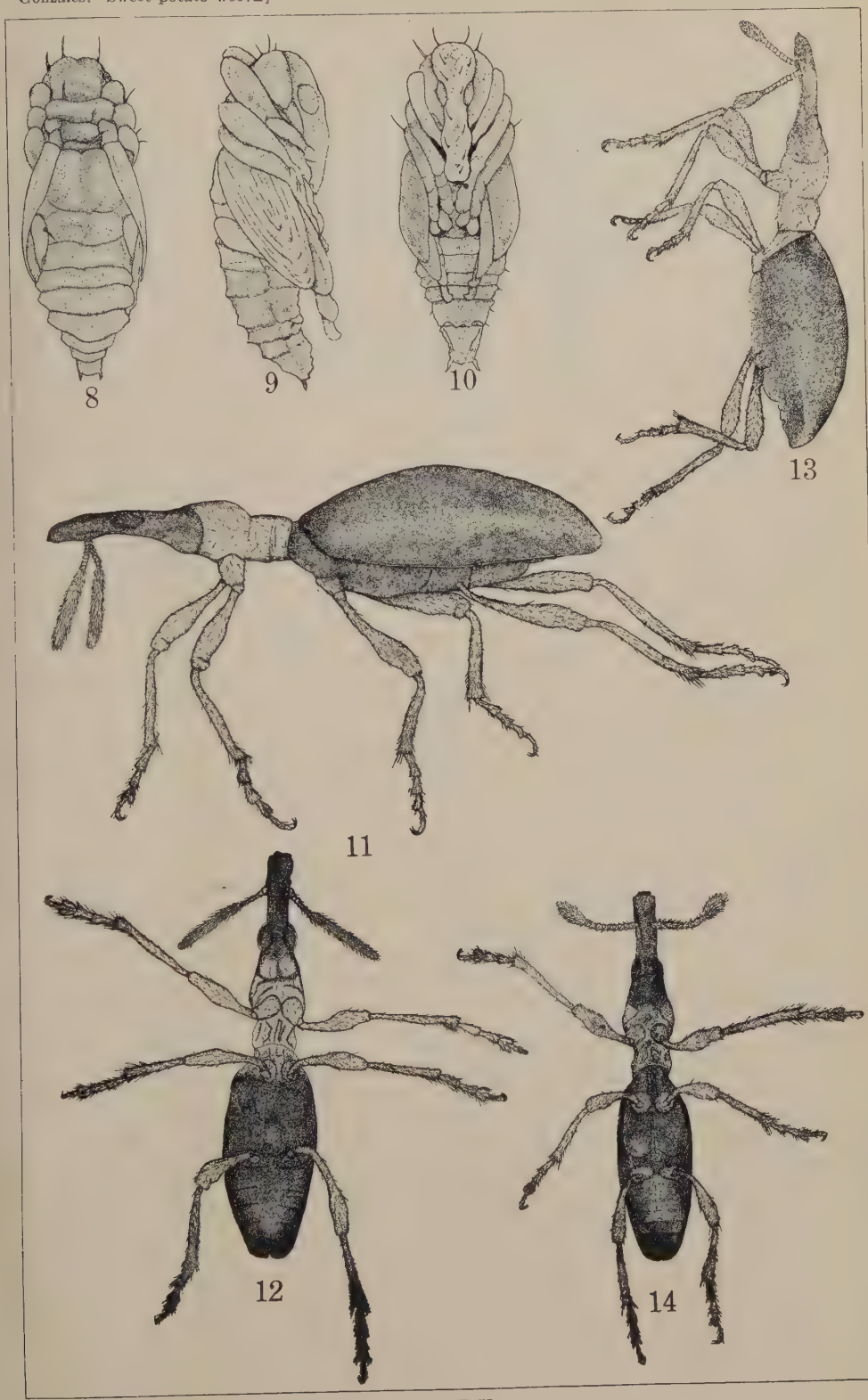

PLATE II

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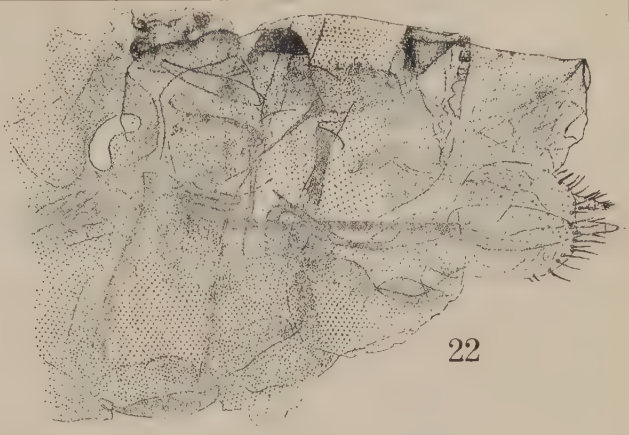

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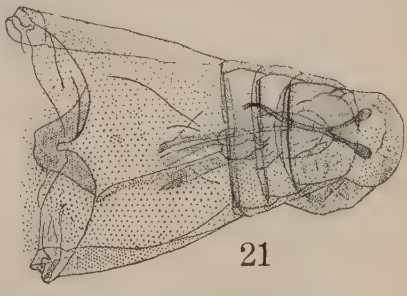

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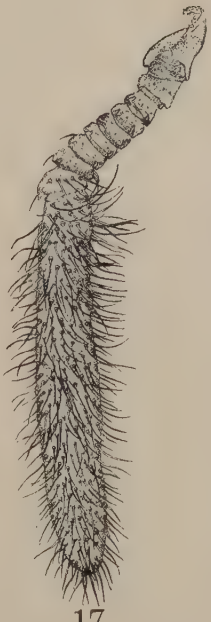

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PLATE III

THE TURKEY INDUSTRY OF AÑGONO, RIZAL[1]

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Of the Department of Animal Husbandry

WITH THREE TEXT FIGURES

Añgono is a barrio of the town of Binañgonan, province of Rizal.[2] It is located about fifteen kilometers to the east southeast of the city of Manila within half a kilometer of the north shore of Laguna de Bay. The provincial road of Rizal passes through the barrio. Añgono is rather hilly and the streets run down the hills to the lake. The major portion of the barrio belongs to a private *hacienda*. The people, in general, seem to be prosperous and happy. They are industrious and very few are without work during any part of the year.

Fishing is the main industry of the people. Second to this is farming with rice the principal crop. During the dry season the lake shore, which is thickly covered with water hyacinth, is reclaimed and planted to corn, rice, and vegetables. There is some cattle raising as the hilly portions of the village furnish excellent pasture. Swine are also raised but to a less extent than cattle. Poultry raising is carried on as a side line. Of the different species of poultry, turkeys predominate with ducks running a close second. Flocks of twenty to thirty ducks are raised by many of the residents. The whites of duck eggs are used to some extent in the treatment of fishnets. There are comparatively few chickens raised, but as is true in most barrios in the Islands, the building that first attracts the attention of a newcomer is the cockpit, the largest structure in the village.

But it is for its turkeys that Añgono has long been famous. Information from reliable sources tells that turkeys have been raised in this place since the middle of the last century and possibly before. An old man who is highly esteemed in the community says that the major part of his expenses while studying in Manila, way back about 1875, was defrayed by the profits from the turkeys raised by his mother. The industry has been passed on year after year increasing somewhat until it is now a recognized paying avocation limited usually to the women. Flocks of turkeys around the houses are as common in Añgono as flocks of chickens are elsewhere. A fondness for poultry, particularly for turkeys, which is so necessary for success in the industry, has been developed. This liking and understanding are especially needed as their care calls for many little attentions and requires much patience.

[1] Experiment Station contribution No. 312.

[2] At the time of this visit, March 14–15, 1925, the necessary papers for the establishment of Añgono as an independent municipality were completed.

THE STOCK

The general opinion of the turkey raisers in Añgono is that the first turkeys in the place were introduced from Pandacan, Manila. The turkeys are similar to the common black variety found throughout the Islands. If they differ in anything, it is in size, the Añgono turkeys being small. Apparently white turkeys are not so popular as black ones as they are far outnumbered in any of the flocks in the barrio. The flocks run from a few to several hundred birds. Most of the turkeys are males. In a flock of fifty it is very seldom that one finds more than five females. Strutting, gobbling turkeys enliven nearly all backyards in Añgono.

INCUBATION

The incubation of the eggs and the rearing of the poults are done in most cases by individuals whose business ends with the weaning of their poults. Only natural incubation is practiced, and for this purpose the turkey hens are used. Turkeys are used in incubation in preference to chickens because they can cover

Fig. 1.—Feeding time. These turkeys have been hand-fed all their lives. Patience and love for the birds help to make turkey raising a profitable occupation.

a great number of eggs at a time. As many as fifteen to seventeen eggs can be placed under a hen at one time with fairly good results. Most of the incubation is done during the months of November and December, but the time may be extended up to April. Practically no eggs are incubated during the rainy season as the poults can not be raised with success during this period.

Only eggs from properly mated females are set. When the hatching season comes, the female turkeys are mated individually. This is done by taking the hen to a tom which is excited and made to cover the hen. The tom is held and placed on the back of the hen which is made by force to sit. This is really a forced mating, and the process, which in itself is an art, stimulates the hens to lay eggs. This process is repeated every day, but before mating the hen, she is examined to see if she has an egg in the oviduct. This examination is made by inserting the forefinger into the vent. If an egg is felt, the bird is not mated but is placed inside a nest which is usually kept under the house. While a single mating is

sufficient to fertilize a whole batch of eggs, the common practice in Añgono is to mate the turkey hens every day until they become broody, except when they have eggs ready to be laid.

MANAGEMENT OF THE POULTS

The people of Añgono realize that the most difficult part of the business of turkey raising is the rearing of the poults to the weaning age. If the poults are hatched during the right season there is practically no mortality during the early ages, and this the raisers ascribe to "good luck". Añgono turkey raisers claim that if a person is unlucky, he will not be able to raise any of his poults to weaning.

Fig. 2.—A *babaan*. These baskets are very satisfactory coops for hardening the poults. They protect from dampness and red ants, both common enemies of young turkeys.

As a cause of failures, poor management of the poults is held to be but of secondary importance.

Before the hatch is taken down, each poult is fed by hand, from one-half to an entire seed of ordinary black pepper, the size given being determined by the apparent condition of the bird. Añgono people claim that the black pepper warms the poults and makes them more active. Until the poults are about a month old and strong enough to run about, they are placed in a circular coarsely woven bamboo basket provided with legs, locally called a *babaan*. The *babaan* is lined with straw and is fitted with a good strong cover made of the same

material or of wire. The brood is kept here most of the time. When the weather is fine, the poults are allowed on the ground for exercise. During the day, this *babaan* is placed in the shade, usually under the house, but during the night, it is taken into the open except when it is rainy or when there are very strong indications that it is going to rain.

The first feed is not given until the day following that when the poults are put down. This feed usually consists of warm soft boiled rice and fresh fine shrimps, *alamang*, which are plentiful and cheap in Àñgono. The poults are fed five or six times a day during the first few days, care being taken not to overfeed them at any feeding time. Ripe banana is also given if it is plentiful. As a rule, hand feeding is practiced; if several poults are noticed to be indisposed to move and do not eat with the others, they are separated from the rest and fed individ-

Fig. 3.—Waiting to be released for their morning run in the rice fields.

ually. As the poults grow older, the number of feedings is decreased until they are ready to be weaned. At this time they are fed but twice a day, in the morning and in the afternoon.

The most delicate period in a poult's life is when it is changing its coat of down into real "turkey feathers". Consequently it is during this time that closest attention is paid to the poults. When the turkey feathers are grown, that is when the poults are about three months old, they are considered as raised. About this time, or sometimes even earlier, some raisers claim that the sex can be determined by the size of the bird. The males are usually larger, coarser in the shanks and hock joints and they are more baldheaded than the females. However, once in a while, even those who claim to be experts in this, err in judgment.

PREPARATION FOR MARKET

When the poults are weaned, they are allowed to mix with and are fed with the older ones. The feed, in most of the cases, consists of a mixture of approximately two parts of rice bran and one part of finely sliced and pounded banana stalks. The banana stalk is cut into thin slices with a rather long thin-bladed cutting knife and then made finer by pounding the slices in a native mortar. This serves as a green feed and as a roughage at the same time.

Once in a while, the turkeys are given a little palay in the morning and in the evening. From about 7:00 to 9:00 o'clock in the morning, and from 4:00 to 6:00 in the afternoon on clear days, the turkeys are driven to the rice fields where they can get insects, bugs, worms, plenty of stray grains and weed seeds, green feed, and above all exercise. The rest of the day, they are confined in the yard. They are made to roost out in the open air on trees in the backyard, but on rainy days they are taken inside. Dampness is recognized as one of the worst menaces to the health of turkeys and for this reason exposure to rain is avoided. No other treatment is given to the turkeys before they are finally marketed.

Special forms of marking the birds are employed so that those belonging to different flocks do not get mixed. The most common of these markings is made by tieing a piece of colored cloth around one of the shanks of the bird. This is a temporary marking; a more permanent one is made by cutting any of the toes of the bird soon after they are brought down. Among mature birds, a simpler mark is by cutting a definite tail feather so that when the turkeys are strutting out in the fields such cut tail feathers become very noticeable.

MARKETING

The turkeys raised in Añgono are generally marketed for the table when they are about ten months old, and sometimes even less. Manila and Fort William McKinley are the centers of consumption for the Añgono turkeys. The turkeys are sold in large numbers on holidays, such as Independence Day, Thanksgiving Day, and Christmas. There are several local buyers who take the turkeys to Manila in auto-trucks, but often army trucks from Fort William McKinley come around and do the buying direct from the raisers. The prices range from ₱6 to ₱10 a head, for the males, depending upon the size. Because they are smaller, females are sold at lower prices.

Turkeys are also sold locally when they are from three to four months old (weanlings). They are sold mostly to persons who make it their business to raise these young birds to maturity ready for sale for the table. At this age, from ₱2.00 to ₱2.50 is generally asked for each head. Those who raise turkeys to maturity very seldom do any hatching at all; they buy the young turkeys from those who hatch the eggs and raise the poults to the weaning age.

DISEASES AND ENEMIES

Diseases affecting the turkey are practically unknown to the turkey raisers in Añgono. Cold seems to be the main cause of the deaths during the early age of the poults. After they have grown "turkey feathers," the poults are considered as good as raised. The loose sandy loam soil and the general hilly location seem to be the most effective factors in helping make the place free from turkey diseases. There was not a single case noted of a bird of poor constitu-

tional vigor. Inasmuch as no breeding turkeys are ever introduced from outside, importation of diseases through immigrants is nil. However, this practice of not introducing new breeding turkeys has tended to produce a distinct reduction in size of the stock, for the larger birds are usually sold first leaving only undersized individuals for breeding.

Turkey-killing dogs and other large animal enemies of turkeys are not found in Añgono, the only danger which threatens the nearly mature turkeys with violent death is the automobile. Not a few mature turkeys are run over by automobiles driven by reckless drivers. These violators of driving regulations should be dealt with severely for they interfere with and harm a thriving business, a business that Añgono is particularly adapted to by nature and nearness to markets, and a business that long familiarity has made a pleasure to those engaged in it.

THE OCCURRENCE OF THE WHITE RUST OF CRUCIFERS AND ITS ASSOCIATED DOWNY MILDEW IN THE PHILIPPINES[1]

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WITH TWO PLATES

The white rust of crucifers and its associated downy mildew were noted on mustard (*Brassica juncea* (L.) Coss.) and pechay, or Chinese cabbage (*B. pekinensis* (Lour.) Skeels) in the vegetable garden of the Department of Agronomy, College of Agriculture, in March, 1925. Mustard infected with white rust and downy mildew was also collected from gardens in Los Baños about four kilometers from the College of Agriculture. The white rust and the downy mildew seem to be intimately connected. Examination of many materials at different times showed that it is often very difficult to obtain mounts of the fruiting bodies of one of the fungi entirely free from conidiophores and conidia of the other. The constant association of the two fungi indicated that the downy mildew organism is parasitic on the white rust fungus. Further examination, however, showed that some of the mustard specimens which were collected from Los Baños had the downy mildew organism although they were entirely free from the white rust fungus.

So far as the writer knows the white rust and its associated downy mildew on crucifers have not been reported, hitherto, from the Agricultural Experiment Station at Los Baños. Published host indexes, notes, and descriptions of Philippine fungi by Ricker (1906), Hennings (1908), Reinking (1918, 1919), Sydow (1910, 1913a, 1913b, 1913c, 1914a, 1914b, 1916), Saccardo (1914), Baker (1914a, 1914b, 1914c, 1916), Mendiola and Espino (1916), Yates (1917, 1918), and Welles (1922), do not show that the white rust and its associated downy mildew on crucifers have been reported from the Philippines.

HOSTS, DISTRIBUTION, AND ECONOMIC IMPORTANCE OF THE WHITE RUST AND ITS ASSOCIATED DOWNY MILDEW

The white rust of crucifers, occurring on members of the Cruciferæ and on some non-cruciferous plants, is of world-wide distribution (Butler, 1918). Reinking (1919) collected the disease in southern China in 1919. The downy mildew associated with the white rust occurs in Europe, especially in England, in the United States (Duggar 1909), in India (Butler, 1918) and now in the Philippines. Thus far the white rust and downy mildew in the Philippines do not occur on cabbage (*Brassica oleracea* L.), and radish (*Raphanus sativus* L.). Severely infected, and old lower leaves of mustard and pechay, or Chinese cabbage were variously deformed or hypertrophied by the white rust. They were nearly covered with spots, yellowed, and some were rendered unsightly by the white rust and downy mildew. No doubt the leaves had little value as vegetables. Specimens of

[1] Experiment Station contribution No. 313. Received for publication, June 1, 1925.

mustard infected with downy mildew alone were not hypertrophied. The downy mildew infection was shown by the yellow irregular areas with brownish dead centers on the leaf blades, especially abundant on the lower older leaves. During the outbreak of the disease at the College of Agriculture about five per cent of the weakened mustard and pechay, or Chinese cabbage, were infected with white rust with its associated downy mildew. In Los Baños, one third to one half of the weakened crop of mustard had worthless lower leaves on account of the downy mildew infection. In general, however, the white rust and downy mildew were found only on poor looking plants and were not doing any damage on the vigorously growing individuals.

Butler (1918) states that, in India, the downy mildew is destructive on stems and leaves and the white rust on the flowers. This author reports that the downy mildew causes serious damage on cauliflower (*B. oleracea* f. *botrytis*), infecting as high as 90 per cent of the crop and in some cases reducing the yield to less than 50 per cent. This author states also that the white rust is of minor importance and does but little damage to crucifers.

SYMPTOMS

White rust

The white rust infection may be recognized by the presence of pale yellow circular to irregular delimited areas on the upper surfaces of the leaves of either mustard or pechay. These discolored areas are abundant and conspicuous on the matured lower leaves. The yellow patches are raised on the upper surface of the leaves and are more or less concave on the lower surface. The infected portions are more or less hypertrophied. White pustules which are either smooth or irregular in shape and range from one-half to two or more millimeters in diameter may be seen on the yellow areas (plate I, fig. 1 and 2). The white pustules are found on both surfaces of the leaves although many of the leaves have more pustules on the lower surface than on the upper.

In advanced stages of infection the discolored areas turn darker yellow, then brown, and finally die. On the borders of these dying areas smaller pustules of the white rust may be seen. When the downy mildew is associated with the white rust the color is a rather dirty white. Microscopic examination of these white fungus growths show that the compact masses composing the pustules are made up of conidiophores and conidia of an Albuginaceæ resembling very closely those of *Cystopus candidus* (Pers.) Lév. syn. *Albugo candida* (Pers.) Roussel. Intimately associated with these is an abundance of conidiophores and conidia of a Peronosporaceæ much like *Peronospora parasitica* (Pers.) Tul. The conidiophores and conidia of the *Peronospora* cause the dirty white color of the pustules. The downy mildew fungus is more abundant on the mustard than on the pechay, or Chinese cabbage.

Downy mildew

When the downy mildew fungus is not associated with the white rust organism, infection is characterized by yellowish irregular areas on both surfaces of the leaves. This type of infection is common on mustard. On the nether surfaces of the leaves there is a downy covering due to conidiophores and conidia. The borders of the infected areas are irregular and distinct. In the advanced

stage of the disease the centers become brownish on account of the death of the tissues. During the dry season drying and tearing of the leaves follow.

When death of the infected mustard leaves takes place, spores of other fungi may also be found on the dead areas. The lesions on leaves of mustard infected with downy mildew alone were not hypertrophied. This observation seems to show that hypertrophy is brought about by the white rust fungus and not by the downy mildew organism.

CAUSAL ORGANISMS[2]

Morphology of the asexual stage of the white rust fungus

Mycelium. The mycelium is unseptate, coarse, hyaline, intercellular, and in abundance in the diseased region and immediate neighborhood. There are numerous knob-shaped haustoria penetrating into the cells of the leaf tissues of the host. The masses of mycelium within the leaf tissues give rise to the palisades of conidiophores which bear catenulate conidia.

Conidiophores. The conidiophores are short, fleshy, thick-walled, clavate, colorless and form a palisade beneath the epidermis of the leaves (plate II, fig. 1). These loosely packed palisades of conidiophores bear a chain of conidia which are connected with each other by means of a neck-like structure or plug of fungus material. The growth and development of these conidiophores and the formation of conidia push the epidermis of the leaf outward, finally rupture it, and expose the conidia and conidiophores to the air. The conidiophores of the Philippine white rust fungus are 17.50-31.32×10.44-15.30 μ. Butler (1918) reports that the conidiophores of *Cystopus candidus* (Pers.) Lév. are 35-40×15-17 μ. Stevens (1913) states that the conidiophores of *Albugo candida* (Pers.) Roussel syn. *Cystopus candidus* (Pers.) Lév. are also 35-40×15-17 μ. Comparing these figures with the measurements obtained by the writer, it may be seen that the conidiophores of the Philippine white rust organism are only about one-half as long although nearly the same in breadth. As the white rust organism has not been reported heretofore from the Philippines it would seem that the smaller size of the conidiophores is due to weather conditions prevalent during the development and fruiting of the fungus and should not be given much weight in taxonomic consideration.

Conidia. The conidia are spherical or nearly so, hyaline, uniformly thin-walled, granular, catenulate, connected with each other in the series by means of a small neck-like structure or plug of fungus material (plate II, fig. 1). The conidia are 11.03-17.50 μ in diameter. Butler's figures for the diameter of the conidia of *Cystopus candidus* are 12-18 μ and those of Stevens for *Albugo candida* are 15-18 μ. From these figures it may be seen that the difference in diameter between the conidia of the Philippine white rust fungus and those of Butler and Stevens is very slight.

Morphology of the asexual stage of the downy mildew fungus

Mycelium. The mycelium is coarse, hyaline, and non-septate with large elongate to clavate and often branched haustoria. In many cases these absorbing organs fill the cells of the host as reported by Butler (1918).

[2] The measurements and drawings were made by Mr. Emiliano F. Roldan, of the Department of Plant Pathology.

Conidiophores. The conidiophores are hyaline, non-septate, long, more or less obclavate, constricted at the point of emergence through the stomata, and are borne in fascicles. The conidiophores are 185-470 μ from the base to the point where the primary branches arise, and 230-580 μ from the base to the highest tip. The widths of the conidiophores at a point midway between the base and the foot of the primary branches are 11-18 μ. The branches are borne dichotomously. There are from two to three main branches, two to four secondary branches, two to three tertiary branches, and two quaternary branches. The tips of the ultimate branches are acute (plate II, fig. 2, 3, and 4). Butler gives the size of the conidiophores of *Peronospora parasitica* (Pers.) Tul. as 200-300 μ while Stevens records the size of the conidiophores of *P. parasitica* (Pers.) de Bary as 200-300×10-12 μ. It may be seen by comparing the figures for the lengths and widths of the conidiophores of the Philippine *Peronospora* that they are slightly larger than those reported by Butler and Stevens. The slightly larger conidiophores that were produced under Philippine conditions would seem to indicate that weather conditions not quite favorable for the development of the white rust fungus were suitable for the development of the *Peronospora.*

Conidia. The conidia are broadly elliptic, hyaline to sub-hyaline, thin-walled, finely granular, (plate II, fig. 5), easily detached, and germinate by the production of germ tubes. Measurements of the lengths and widths of 200 conidia from fresh materials were made and the figures distributed in classes made by a difference of two microns following Rosenbaum's (1917) method for the study of species of the genus *Phytophthora.* The results are given in table 1.

TABLE 1

Showing the distribution of lengths and widths of 200 conidia of the Peronospora parasitic on Chinese cabbage and mustard in classes made by a difference of two microns

LENGTH CLASSES	NUMBER OF CONIDIA IN 200	WIDTH CLASSES	NUMBER OF CONIDIA IN 200
microns		*microns*	
—— ——	—	8.5—10.49	10
—— ——	—	10.5—12.49	7
12.5—14.49	4	12.5—14.49	71
14.5—16.49	11	14.5—16.49	33
16.5—18.49	93	16.5—18.49	29
18.5—20.49	17	18.5—20.49	15
20.5—22.49	31	20.5—22.49	27
22.5—24.49	29	22.5—24.49	8
24.5—26.49	8	—— ——	—
26.5—28.49	6	—— ——	—
28.5—30.49	1	—— ——	—

In table 1 it may be seen that although the lengths of the conidia vary from class 12.5-14.49 μ to class 28.5-30.49 μ and the widths vary from class 8.5-10.49 μ to class 22.5-24.49 μ, the greatest number of the conidia have lengths in class 16.5-18.49 μ and widths in class 12.5-14.49 μ. The average size of the conidia based on measurement of 200 is 19.72×16.06 μ, and the average ratio of length to width is 1.22.

According to Butler the conidia of *Peronospora parasitica* are 24-27×15-20 μ. Stevens gives the size of the conidia as 24-27×12-22 μ. The writer's figure for the average size of the conidia of the Philippine *Peronospora* is slightly smaller. In table 1, however, it may be seen that the distribution of the lengths

of conidia is 12-30 μ and the widths 8-24 μ. Considering this distribution of the size of the 200 conidia measured, it may be seen that both Butler's and Steven's figures lie within the range of the lengths and widths of the conidia of the Philippine *Peronospora*. Since the number of conidia on which the figures reported by Butler and Stevens are based is not known, and size of fruiting bodies alone, if based on a small number, is not the only important criterion to consider in the taxonomy of fungi, the *Peronospora* of crucifers in the Philippines is very closely related to *Peronospora parasitica*.

SEXUAL OR OOSPORIC STAGES OF THE WHITE RUST AND DOWNY MILDEW FUNGI IN THE PHILIPPINES

Thus far no sexual or oosporic stages of the white rust and downy mildew fungi in the Philippines have been found either in the field or in the laboratory, although careful search for them has been made. The absence of oospores is believed to be due to the influence of weather conditions in the growing season.

TAXONOMY

The white rust fungus

The asexual stage of the white rust fungus in the Philippines produces nearly one-half as short and slightly narrower conidiophores, and the conidia are also smaller than the figures reported by Butler and Stevens for these structures in *Cystopus candidus* or *Albugo candida*. The Philippine fungus studied did not have the sexual stage. The other morphological characters, however, show remarkable similarity to those of *Cystopus candidus* (Pers.) Lév. syn. *Albugo candida* Roussel. The writer believes that the Philippine white rust fungus is identical with *Cystopus candidus* (Pers.) Lév.

The downy mildew fungus

Measurements of the conidiophores of the Philippine *Peronospora* show that they are slightly larger than those of *P. parasitica* reported by Butler (1918) and Stevens (1913). The writer's figure for the average size of the conidia shows that the spores of the Philippine downy mildew fungus are slightly smaller. If the range of the lengths and widths of the conidia are considered in the comparison of the size of the spores, it may be seen that the conidia of the Philippine *Peronospora* agree with those of *P. parasitica*. The reason for the rather smaller sized conidia of the Philippine *Peronospora* might be the age at the time the specimens were collected and measured. Like the *Cystopus candidus* with which it is often associated the Philippine *Peronospora* did not have the oosporic stage even in tissues of mustard and pechay which were allowed to die and rot in the laboratory and in the field. Other characteristics of the fungus, constant association with the *Cystopus candidus*, and effect upon the host, either when associated with the white rust or alone, show close similarity with those of *Peronospora parasitica* (Pers.) Tul. Until the economic importance of the disease warrants a further and more detailed study of the organism to prove that the fungus is a different species, the writer considers the Philippine *Peronospora* on crucifers identical with *P. parasitica*.

CONTROL MEASURES

The white rust of crucifers and its associated downy mildew are minor diseases and occasion but very little loss to mustard and pechay. In the present state of these diseases no special control measures appear necessary. The removal of infected leaves or entire plants, and burning to prevent the spread of these diseases in the field are sufficient. Clean cultivation and production of strong plants in the field will materially help to reduce infection.

Butler states that the white rust is usually of little economic importance and requires no definite control measure. In connection with the downy mildew this author makes the following recommendations which might be of value in case the disease should become epiphytotic in the Philippines.

1. Clean weeding and removal of all cruciferous weeds harboring the downy mildew.
2. Spraying with Bordeaux mixture, potassium sulfide, or other fungicides in cases of severe infection.
3. Destruction of crop refuse at the end of the season to rid of oospores.
4. Rotation of crops using non-cruciferous plants.
5. Mulching of young plants with sawdust saturated with copper sulfate has been reported as having checked infection.

SUMMARY

The white rust of crucifers caused by *Cystopus candidus* (Pers.) Lév. syn. *Albugo candida* (Pers.) Roussel and the downy mildew due to *Peronospora parasitica* (Pers.) Tul., which were hitherto unreported from the Philippines were collected in the early part of 1925 on mustard and pechay grown in the gardens of the College of Agriculture at Los Baños and vicinity, Laguna Province. These diseases are of little economic importance at present and cause damage only on weakened plants. The conidia and conidiophores of the *Cystopus candidus* in the Philippines are slightly smaller than those reported elsewhere. The conidia of *Peronospora parasitica* are also slightly smaller although the conidiophores are a trifle larger. The smaller size of the conidia is probably due to age at the time the specimens were collected and measured. Thus far no sexual or oosporic stages of either fungus have been found. As the diseases are of little economic importance and weak plants only are infected, only general sanitary measures and production of vigorous plants are necessary in order to control both diseases.

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ILLUSTRATIONS

PLATE I

Fig. 1. A leaf of pechay, or Chinese cabbage (*Brassica pekinensis* (Lour.) Skeels) showing white pustules of the white rust due to *Cystopus candidus* (Pers.) Lév. on the lower surface of the leaves. Note the pustules indicated by the arrow heads. On these pustules conidiophores and conidia of *Peronospora parasitica* (Pers.) Tul. are sometimes obtained. Slightly reduced.

Fig. 2. A leaf of mustard (*Brassica juncea* (L.) Coss.) showing white pustules of the white rust but more or less masked by the dense growth of the downy mildew fungus. Note the pustules indicated by the arrow heads. A lower surface view of the leaf slightly reduced.

(Photograph by the Photographic Division, Department of Agronomy, College of Agriculture, Los Baños, Laguna, Philippine Islands.)

PLATE II

Fig. 1. Portion of the cross section of a leaf of pechay, or Chinese cabbage showing conidia and conidiophores of *Cystopus candidus* (Pers.) Lév. and part of the ruptured lower epidermis of the leaf of the host. Note the intercellular hyphæ in the spongy parenchyma of the

leaf. (From a free hand section drawn by Mr. Emiliano F. Roldan with the aid of a camera lucida using a Bausch and Lomb microscope, ocular 7.5×, and 4 mm. objective. ×260.

Figs. 2, 3, and 4. Conidiophores of *Peronospora parasitica* (Pers.) Tul. scraped from fresh specimens showing the dichotomous branching, the constrictions at the bases, the long main stalk, and the acute tips of the ultimate branchlets. (Drawn by Mr. Emiliano F. Roldan using a Bausch and Lomb microscope, ocular 7.5×, and 4 mm. objective. ×260.

Fig. 5. Camera lucida drawing of conidia of *Peronospora parasitica* showing the broad elliptical shape and the thin walls. (Drawn by Mr. Emiliano F. Roldan using a Bausch and Lomb microscope with 6× ocular and a 4 mm. objective.) ×270.

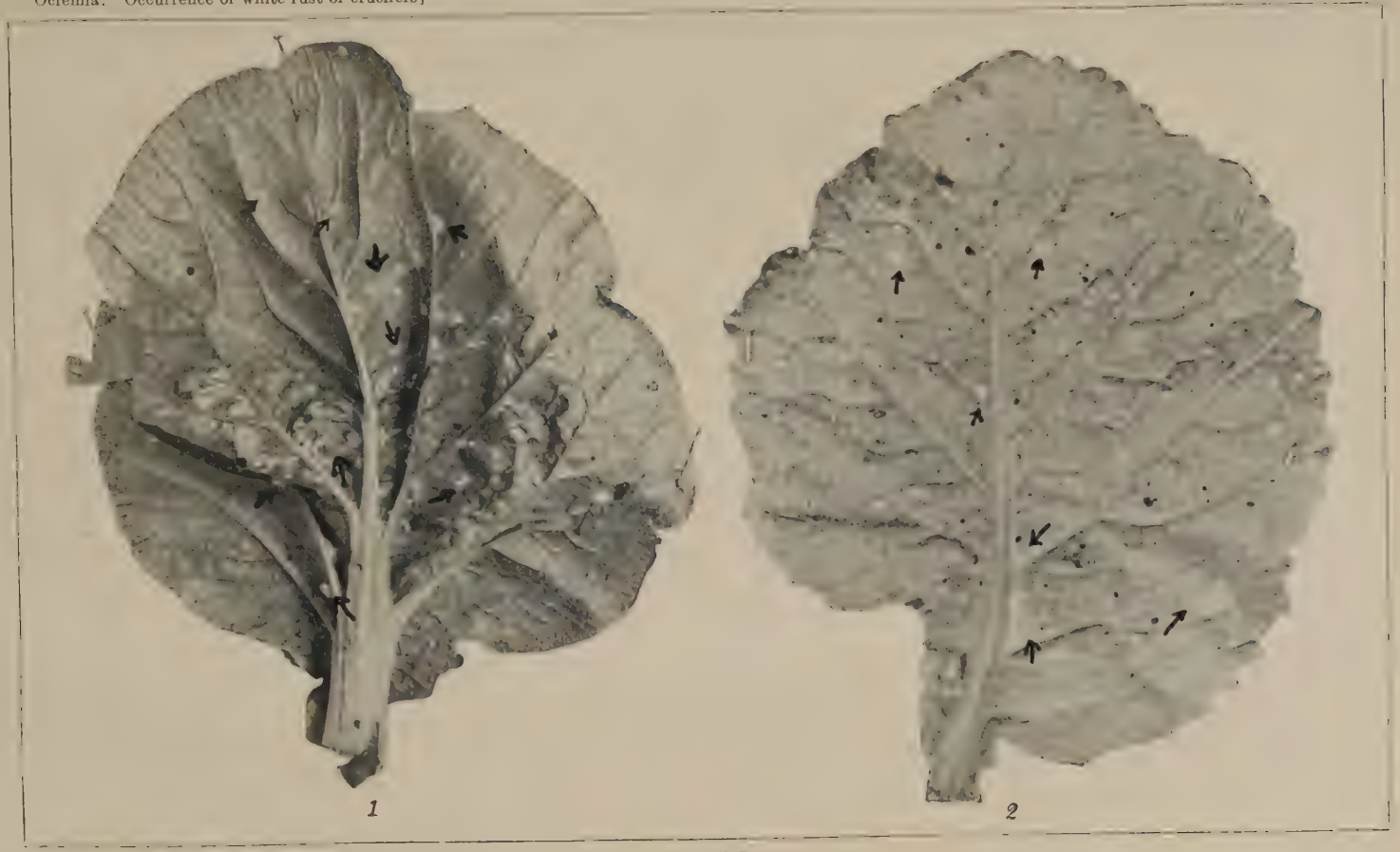

PLATE I

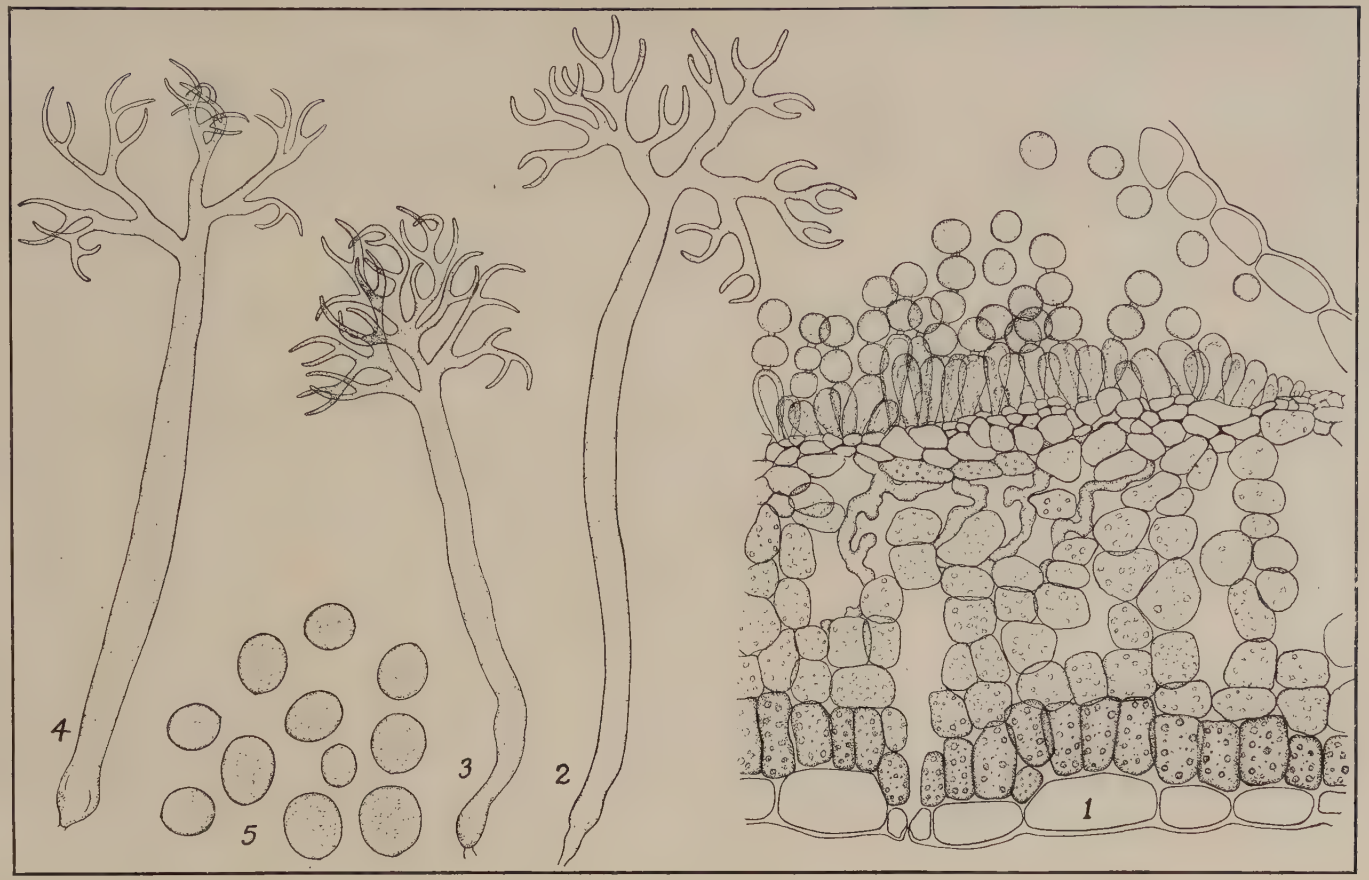

PLATE II

PLOWS AND PLOWING: III. DRAFT TESTS ON FOUR MAKES OF SINGLE-ANIMAL WALKING PLOWS[1]

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WITH TWO TEXT FIGURES

Plow draft has not been given much attention in the Philippines. No tests throwing light on this important factor in soil cultivation have been published in this country. This paper gives the results of some preliminary tests made by the writer on the drafts of four makes of walking plows.

The object of these tests was to determine the draft per square centimeter of cross section of furrow slice of plow in operation, when plowing at uniform depth and at constant speed. In addition the quality of the work of each plow under different conditions was compared. In all of the tests made the hitch was considered to be the right one for each make of plow, due regard being given to depth and width of plowing.

The work was performed in the latter half of the year 1924 under the following conditions: The first series of tests was made on August 6. The soil during these tests was saturated with water, making plowing very disagreeable. The second series of tests was made on August 16. During the ten days intervening between the first and second series, the weather was extremely dry. This condition made the upper layer of the soil dry to a depth of about eight centimeters. The third series of tests was carried out on September 12. The weather condition between the second series and the third was fair, bringing about very satisfactory results, so far as the condition of the soil for plowing was concerned. The fourth series was made on October 15. The soil condition during this series was a little too dry for ideal plowing.

MATERIALS AND METHODS

The plows used in these tests were obtained from the Pacific Commercial Company, Macleod and Company, and Bazar Siglo XX, all Manila firms. They are all single-animal walking plows, with moldboard bottoms. The plows were named by the three companies as follows:

1. Luzon Lagio..... Pacific Commercial Company
2. Negros..... Pacific Commercial Company
3. Chattanooga No. 70 X..... Macleod and Company
4. Vargas..... Bazar Siglo XX.

[1]Experiment Station contribution No. 314.

The drafts were taken with a non-selfrecording tractometer which was manufactured by the Slausson Tractometer Company of Los Angeles, California. One bullock was used to pull the plow in all the tests; the same plowman was used in all tests. Three hundred draft readings were recorded during the test of each plow.

Each test was made over a distance of 350 meters, the speed depending upon the strength of the bullock. A point was made of walking the animal in such a way that, with the pull it was carrying, it would be able to plow continuously for three hours in the morning and three in the afternoon. Six hours plowing a day is considered a good full day's work for a bullock at the College.

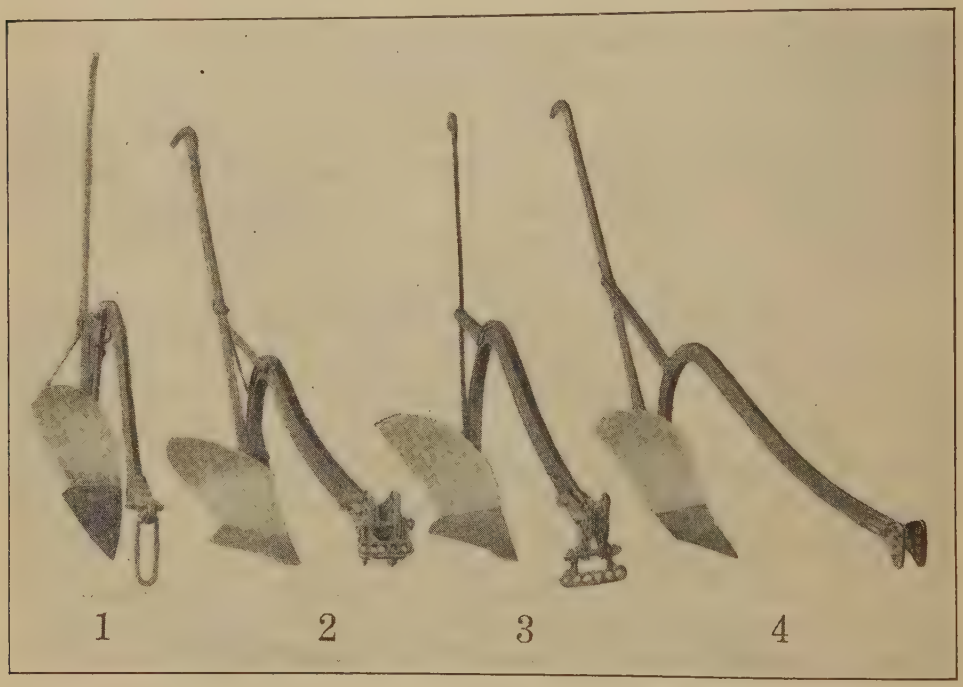

Fig. 1. Makes of plows used: 1. Vargas; 2. Chattanooga No. 70 X; 3. Negros; 4. Luzon Lagio.

Measurements of depth and of width of furrow were made with the use of a home-made instrument. Fifty width measurements and one hundred depth measurements were made during each test. Each measurement was made at such a distance as to insure regularity of furrows and to give a fairly general average of the whole field.

Four series of tests were made for each plow with the exception of the Vargas which was tested only twice. Each plow was required to plow on four kinds of soil under different conditions. The return furrow in each test was made on the side of the land opposite to where the other tests were made.

The description of the different kinds of soil plowed is presented in table 1.

TABLE 1

Description of the field plowed

FIRST TEST AUG. 6, 1924	Soil, clay loam in nature; over-saturated with water; level; few herbaceous weeds growing; had been plowed about a month before the test.
SECOND TEST AUG. 16, 1924	Soil, a portion of the field used in test No. 1; upper layer (covering 8 cm. from the surface) very hard and dry; layer below this moderately moist; many herbaceous weeds growing.
THIRD TEST OCT. 15, 1924	Soil, clay loam with some silt; ideal for plowing as far as moisture content was concerned; level; corn stubble and vines (weeds) covered the field.
FOURTH TEST OCT. 15, 1924	Soil, mixture of adobe, clay, and loam, with loam predominating; a little too dry for plowing; layer, 1 cm. below surface moderately moist; slightly sloping on one side of the field; surface, undulating on account of deep furrowing made for the cultivation of corn grown previously; furrow crest, about 7 cm. above the furrow sole; thickly covered with corn stubble and partly decayed corn stalks.

The different fields were portions of the College Experiment Station Ground. The draft per square centimeter of cross section of furrow slice was determined by dividing the average total pull by the average total area of cross section, the area of cross section being found by multiplying the average depth by the average width of the furrow.

RESULTS

The results of the tests are arranged in tables 1 and 2, and are plotted in graph 1.

TABLE 2

Results of all the tests

NAME OF PLOW	TEST NO.	KIND OF SOIL	SIZE OF FURROW SLICE			DRAFT		SPEED PER HOUR
			Average depth	Average width	Average area	Total draft	Draft per unit area	
			cm.	*cm.*	*sq. cm.*	*kgm.*	*gm. per sq. cm.*	*kgm.*
Chattanooga No. 70 X	1	Very wet clay loam	14.88	20.97	312.03	39.71	127.30	1.27
	2	Very dry clay loam	13.73	20.37	279.72	89.65	320.39	2.01
	3	Moist ideal clay loam	12.77	19.89	253.87	76.23	300.00	1.74
	4	Moderately moist adobe clay loam	9.74	20.52	199.86	56.56	283.01	1.80
Luzon Lagio	1	Very wet clay loam	15.16	19.79	300.04	44.00	146.56	1.27
	2	Very dry clay loam	13.61	21.29	289.80	80.73	278.42	2.01
	3	Moist ideal clay loam	12.35	22.07	272.64	81.33	298.25	1.74
	4	Moderately moist adobe clay loam	9.47	20.87	197.70	60.65	307.38	1.80
Negros	1	Very wet clay loam	15.27	23.12	352.84	54.16	153.45	1.27
	2	Very dry clay loam	12.79	22.63	289.49	85.90	296.84	2.01
	3	Moist ideal clay loam	11.44	21.84	249.84	88.50	354.13	1.74
	4	Moderately moist adobe clay loam	8.81	23.10	203.53	74.12	364.04	1.80
Vargas	3	Moist ideal clay loam	11.37	20.85	237.06	93.63	394.97	1.74
	4	Moderately moist adobe clay loam	9.75	20.80	202.74	77.08	380.19	1.80

DISCUSSION OF THE RESULTS

Quality of the work

The writer based the discussion of the quality of the work done by each plow upon four principal factors: namely, (1) pulverization; (2) uniformity of texture; (3) complete covering of trash; and (4) uniformity throughout the surface of the furrows.

Chattanooga No. 70 X. In the first series of tests, when the plowing was done on very wet soil, the Chattanooga plow turned the soil in big clods. The soil particles did not fall apart in the act of plowing. In the second series, the presence of large spaces and of large clods on the furrow slice was noticeable. The plow had the tendency to move out of the ground in this series of tests.

The Chattanooga exhibited its best quality of work in the third and fourth series of tests. The furrow slice was better pulverized from top to bottom. The trash was almost completely buried and the ground was packed closely around it. The height and curvature of the furrow crown was more uniform with the use of the Chattanooga than with the use of the other plows. This was found to be true especially in the fourth series of tests where the ground was undulating.

This plow scoured the best in all of the tests; the Negros plow, discussed below, coming a close second. This result might be due to the fact that the Chattanooga is a chilled plow.

Negros plow. The Negros plow broke up the furrow slice in the first two series of tests into clods much smaller than those made by the other plows. The quality of the work in the third and fourth series was quite similar to the work of the Chattanooga. Like the Chattanooga, it cut a nearly smooth furrow bank and furrow bottom.

Luzon Lagio plow. The Luzon Lagio plow broke up the furrow slice into large clods in the first and second series of tests. Better work of pulverization was done in the third and fourth series.

A portion of the furrow bottom was not cut entirely off while plowing. The furrow slice was poorly turned and oftentimes had the tendency to roll back to the furrow. Many weeds could be seen protruding between the furrow slices.

The share of this plow had excellent penetration in all of the tests made. Its bottom scoured almost as well as that of the Negros plow.

Vargas plow. The Vargas plow was used only in the third and fourth series of tests when the condition of the soil was ideal for plowing. Its penetration was considerable because of the shape and sharpness of its share. As with the Luzon Lagio, a portion of the furrow bottom was not entirely cut off. The furrow bottom was almost triangular and was very rough. A greater part of the furrow slice rolled back to the furrow. The furrow bank was slanting toward the plowed ground. A portion of the furrow slice was thrown over the unplowed side of the bank during the time of plowing.

Drafts

The total draft and the average draft per square centimeter of furrow slice (Fig. 2) was less in the first series of tests than in any of the others. This may have been due to the fact that the field had been plowed about a month before the tests were made. There were also very few weeds, mostly herbaceous, growing during the tests.

The Chattanooga made the least average draft during the first series of tests. The Negros plow made the heaviest draft in this series. The Chattanooga mold-

board inverted the soil without breaking it into small particles while the Negros moldboard produced a very much better pulverization.

The second series of tests showed a higher average than the first series both in total draft and in draft per square centimeter. This result may have been due to the different degrees of hardness of the soil, as it was very dry in the upper eight-centimeter layer and moderately moist below. There were also more weeds growing during this series of tests.

The Luzon Lagio plow had the least draft and the Chattanooga had the heaviest. The excellent penetrating power of the Luzon Lagio share and the shape of its moldboard, which turned the furrow slice into large clods not more than half over, may have had something to do with its having the lightest draft.

The four plows that were used in the third and fourth series of tests made high average in total drafts and in drafts per square centimeter. The Chattanooga and the Luzon Lagio had the least draft per square centimeter in the

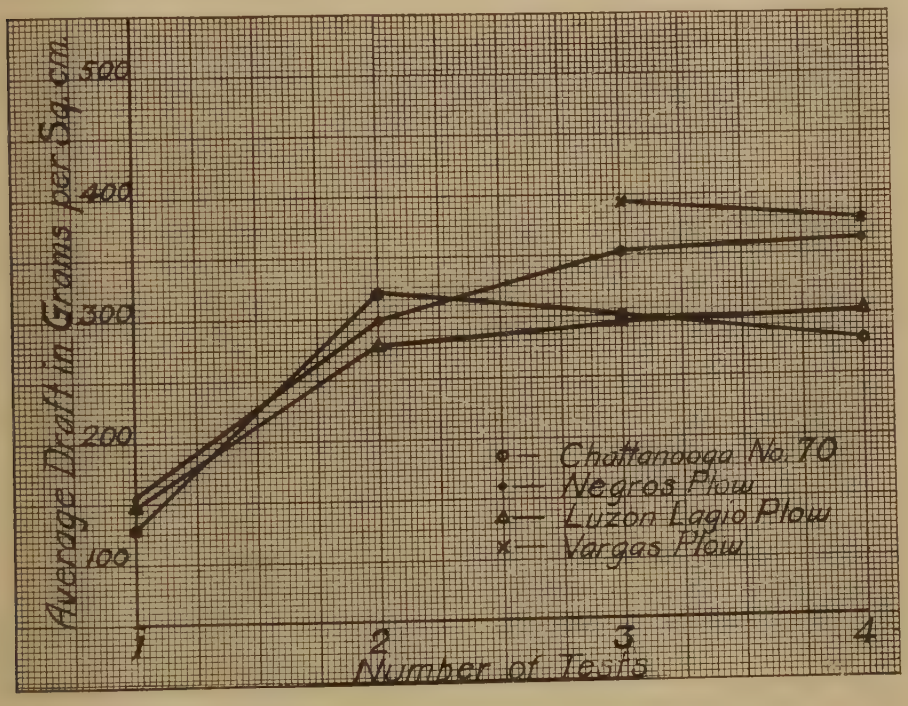

Fig. 2. Comparison of the average draft per unit area of furrow slice in the different series of tests.

third series. The smallest average draft in the fourth series was made by the Chattanooga plow.

The high average obtained when the condition of the soil was ideal may have been due to the better quality of the work done by each plow.

CONCLUSION

In view of the foregoing considerations, it seems justifiable to conclude that the ordinary walking moldboard plows of the types tested in the present study pulled easier in a wet clay loam soil that had been plowed about a month before the test was made, than in an unplowed, weedy, clay loam soil in good plowing condition. Less power was needed for plowing of poor quality than for plowing of good quality. A plow that did good work in soil that was in suitable condition for plowing made a poor showing when tested on the same kind of soil that was either too wet or too dry.

GRAIN SUPPLEMENTS FOR RAISING WATER BUFFALO CALVES[1]

ENRIQUE M. SIBAL

The raising of calves is a matter that should be given careful attention. The future of a herd depends in a large measure upon the care given to the calves from which the heifers are obtained to take the place of the old cows. According to Humphrey and Markey (1916), the surest and cheapest way to secure a profitable dairy herd is to raise it, as home raised heifers generally develop into better and more profitable cows than those which may be purchased.

When the price of milk is high, it is desirable that the calves be weaned rather early so that the maximum production of milk from their dams may be obtained. The use of suitable and cheap grain supplements for raising these calves, accompanied with the best of care and management, will undoubtedly help to secure good results, thereby contributing to the operation of a paying and thrifty herd of dairy cows.

In the rearing of heifers, six to eight months old, Henry and Morrison (1921) say that a concentrate allowance, rich in protein and mineral matter, should be given unless leguminous hay is used as the main roughage. This suggestion is supported by McCandlish (1922), who says that concentrates provide muscle and bone-building nutrients, such as protein and ash. Allen (1919) suggests that a calf six months old should be fed grain mixtures at the rate of one pound a day for the first 100 pounds of the animal's weight and one-half pound more for each additional 100 pounds. The calf should be given all the roughage that it will eat and plenty of fresh water to drink. A handful of salt at least twice a week should be given.

In undertaking this work, it was the aim of the writer to determine a suitable mixture for feeding water buffalo calves after weaning, when Guinea grass (*Panicum maximum* Jacq.) is the sole roughage used. The determination was made by comparing the value of leguminous proteins, such as are found in mungo (*Phaseolus max.*), with proteins from copra meal when fed in combination with corn and rice bran.

This work was conducted in the Department of Animal Husbandry, University of the Philippines. The experiment covered a period of 144 days, from July 9, 1923, to November 30, 1923.

MATERIALS AND METHODS

Calves

Throughout the experiment six calves were used. Three of these were carabaos[2], two were Indian buffaloes, and one Indian-native.

[1] Thesis presented for graduation, 1924, with the degree of Bachelor of Agriculture from the College of Agriculture No. 206; Experiment Station contribution No. 315. Prepared in the Department of Animal Husbandry under the direction of Dr. Valente Villegas.

[2] Carabao, name used in the Philippines for water buffalo.

TABLE 1

Showing the animals used in each lot

LOTS	HERD NO.	SEX	INITIAL AGE	BREED	INITIAL WEIGHT	FINAL WEIGHT	GAIN IN 144 DAYS
			days		*kgm.*	*kgm.*	*kgm.*
I	11	F	201	Indian	121.36	195.83	74.47
	30	M	207	Native	110.45	132.34	21.89
	31	F	200	Native	75.59	81.43	5.84
		Average	203	—	102.47	136.53	34.07
II	10	F	231	Indian	173.63	220.53	46.90
	29	F	226	Grade	125.50	180.71	55.21
	32	F	152	Native	105.96	122.19	16.23
		Average	203	—	135.03	174.48	39.45
Difference between Lots I–II			0	—	32.56	37.95	5.38

The calves were grouped according to their ages. Calves 31 and 32 were the smallest and appeared rather unthrifty; the other four were normal in health and condition, especially the two Indian buffalo calves.

Pens

The calves were fed and kept in adjoining pens in the morning. In the evening, whenever the weather permitted, they were turned into a yard where a little grass was growing to exercise.

Grain mixture

Two kinds of grain mixtures were formulated, with an approximate nutritive ratio of 1:4.7. Combination I consisted of rice bran 10 parts, by weight, copra meal 8 parts, and ground corn, 1 part. Combination II consisted of rice bran 10 parts, by weight, ground mungo 8 parts, and ground corn 2 parts. The rice bran used was obtained from Santa Rosa and Cabuyao in the province of Laguna. The price paid was ₱1.55 a cavan (about 25 kilograms). The copra meal came from the Oriental Oil Co. in Manila, costing ₱35.50 a ton. The mungo was bought in Los Baños at ₱0.50 a ganta (about 2.2 kilograms). The greater part of the corn used was obtained in Calamba at ₱5.00 a cavan, the rest came from the College Farm.

Three samples of each grain mixture were taken to the Analytical Laboratory of the College of Agriculture for analysis. The average results of the analysis are given in table 2.

TABLE 2

Showing the average analysis of three samples of each of the two grain mixtures used

CONSTITUENTS	GRAIN MIXTURE I	GRAIN MIXTURE II
	per cent	*per cent*
Moisture	11.98	10.79
Fat (Ether extract)	6.97	4.67
Ash	11.01	9.23
Protein (N×6.25)	13.75	13.78
Crude fiber	14.62	10.55
Carbohydrates	41.62	50.96
Total	99.95	99.98

System of feeding

From July 9, 1923, to October 20, 1923, the calves in both lots were fed with the grain mixtures twice a day, in the morning and in the afternoon. From October 21, 1923, to the end of the experiment, November 30, 1923, the grain mixtures were fed three times a day, in the morning, at noon, and in the afternoon. The calves were fed each time just what they would clean up within about twenty minutes. When some of the calves were off feed, the usual amount was cut to one-half and then increased gradually as the calves began to eat again. Except in the months of August, October, and first half of November when the supply was limited, the calves were fed each day as much Guinea grass as they could eat. They were watered three times a day, usually after feeding the grain.

Weighing

The calves were weighed every ten days. The weighings were made early in the morning before feeding.

EXPERIMENTS AND RESULTS

Results

Lot I. No. 11 showed a greater increase than the other two calves in this lot, a total of 74.47 kilograms, or an average daily gain of 0.51 kilogram. Calf No. 30 came second, gaining 21.89 kilograms, or an average daily gain of 0.15 kilogram. This calf was rather poor, being pot-bellied, and the hair on the body was rather long. At times it was heavily infested with lice, which were removed. Calf No. 31 gained only 5.84 kilograms, or an average daily gain of 0.04 kilogram. This calf was the smallest animal in the experiment and showed the poorest development. She became stunted and developed long hair. Her size remained almost at a standstill from the start to the end of the test.

At the close of the experiment, calf No. 11 appeared healthy and in good flesh, while Nos. 30 and 31 were stunted, unthrifty, and rather weak. The abnormal condition of these two calves was particularly shown by their hair being long and lusterless. Also, the skin was rough and did not have the oily appearance of a healthy animal.

During the early part of October there was a scarcity of Guinea grass, but only No. 31 showed loss in weight. The decline in the weights of the calves during different periods of the experiment was probably due to the limited supply of the Guinea grass.

Lot II. No. 10, an Indian buffalo calf, gained 46.9 kilograms, or an average daily gain of 0.33 kilogram. This was the largest calf in this lot and it kept in fairly good condition from the beginning to the end of the experiment. The best development among the calves in this lot was shown by calf No. 29, an Indian-native calf which even exceeded Indian buffalo calf No. 10 in rate of growth. It made a total gain of 55.21 kilograms, or an average daily gain of 0.38 kilogram. It was also like calf No. 10 in maintaining its health and keeping in good condition throughout the experiment. Examination made at the close of the work showed that this calf was normal and thrifty in condition. Calf No. 32, which was the smallest calf in this lot, showed the poorest development. It made a total gain in weight of only 16.23 kilograms, or an average daily gain of 0.11 kilogram. The weakest and most unthrifty calf in this lot continued to grow in

height but did not gain much in weight, keeping poor in flesh and appearing weak. During the experiment this calf became at times badly infested with lice. The skin was dull and the hair long and lusterless.

Comparison of the two lots. The average weight of the calves in lot I and lot II are shown in table 1. The average gain of the calves in lot I was 34.07 kilograms, or an average daily gain of 0.23 kilogram for each calf. The average gain of the calves in lot II was 39.44 kilograms, or an average daily gain of 0.27 kilogram for each. These figures show that lot II apparently was the better of the two. Considering, however, that the calves in lot II were more growthy to begin with, the slight advantage should not be given too much importance.

A comparison from each lot of calves of similar development at the beginning of the experiment proves illuminating: No. 11 in lot I and No. 29 in lot II started with approximately the same weight. No 11, from the copra meal fed lot, gained 74.47 kilograms, while No. 29 from the mungo meal fed lot gained 55.21 kilograms. Similarly, No. 30 of the copra meal lot gained more than No. 32 of the mungo lot. This contradicts the results obtained by averaging the animals in each of the lots. It was most unfortunate that the animals could not have been distributed more uniformly as to development as well as to age.

The poorer calves were found many times badly infested with lice, which seems to be often the case with poor, emaciated animals. Efforts were made to remove the parasites as often as possible. A pertinent question suggests itself as to whether the parasites caused the lack of thrift of the animals or whether the lack of thrift of the animals encouraged the multiplication of the parasites. In this connection, Hulce and Nevens (1917) state that calves infested with lice do not thrive.

Calves Nos. 30 and 31 in lot I and No. 32 in lot II which at the end of the experiment turned out to be the poorest individuals, were among the smallest and weakest at the start of the test. This would seem to show that the raising of weak and undersized calves is difficult; such calves must first receive a plentiful supply of milk to bring them to the proper size and condition before they can be weaned and properly raised on roughage and grain.

The total amount of grain consumed by the calves in lot I was 403.6 kilograms, or an average daily consumption of 2.8 kilograms. The calves in lot II consumed a total of 566.5 kilograms, or an average daily consumption of 3.93 kilograms. The great difference in the total and the average daily consumption between the calves in lot I and those in lot II was because the calves in lot II were more voracious feeders than those in lot I. Also, the grain mixture given to lot I was looser in texture than that given to lot II and hence weighed less per unit volume. The chemical analysis of the mixtures used showed little difference.

The calves consumed more grass as they grew older. The average daily consumption of the calves in lot I was 50.8 kilograms, or a daily consumption of 16.9 kilograms per calf. The calves in lot II consumed an average of 64.31 kilograms, or a daily consumption of 21.6 kilograms per calf.

The total cost of feeds consumed by lot I during the whole period of the experiment was ₱57.50, or an average cost of ₱19.17 to raise each calf. On the other hand, the calves in lot II consumed feeds costing ₱119.67, or an average cost of ₱39.89 against each calf. These figures show that the calves in lot II

which were fed with the grain mixture containing mungo as the nitrogenous constituent, cost more to raise than the calves in lot I which were fed with the grain mixture containing copra meal in place of mungo. This large difference was due to the high price of the mungo that was fed to the calves in lot II.

SUMMARY

1. From this experiment it appears that the feed value of copra meal and mungo for buffalo calves receiving rice bran and corn and Guinea grass as sole roughage, is not materially different.

2. From the point of view of cost, copra meal proved to be much the cheaper feed. The high cost of mungo precludes its extensive use for calf feeding.

3. No deleterious effects which could justly be attributed to either copra meal or mungo were noticed in the calves.

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ABSTRACT

Temperature as a factor in nitrogen changes in the soil. Elias H. Pañganiban. *Journal, American Society of Agronomy* **17**: 1-31. 1925. *Experiment Station contribution No. 316.* In view of the fact that very little work has been done on the effect of temperature upon the nitrogen changes in the soil, a series of experiments were carried on to determine the effect of constant and alternating temperatures upon ammonification, nitrification, denitrification, and nitrogen fixation under ærobic and anærobic conditions in the soil.

For constant temperatures, the following were used: 15°, 20°, 25°, 30°, 35°, and 40° C.

For alternating temperatures, the same temperatures were used and alternated as follows:

(1) Alternating by 5° C. difference: (*a*) 15°-20° C.; (*b*) 20°-25° C.; (*c*) 25°-30° C.; (*d*) 30°-35° C.; (*e*) 35°-40° C.

(2) Alternating by 10° C. difference: (*a*) 15°-25° C.; (*b*) 20°-30° C.; (*c*) 25°-35° C.; (*d*) 30°-40° C.

(3) Alternating by 15° C. difference: (*a*) 15°-30° C.; (*b*) 20°-35° C.; (*c*) 25°-40° C.

The soils used were obtained from the experimental field of Cornell University Agricultural Experiment Station. They are Dunkirk silty clay loam, Clyde clay loam, and Dunkirk gravelly fine sandy loam.

The results of the study are as follows:

Ammonification. The effect of constant temperature shows that there is an increased ammonification as the temperature was increased up to 40° C. This result seems to indicate that the thermophilic, or the heat loving organisms are active ammonifiers. With another set of experiments, using higher temperatures, 35°, 40°, 45°, 50°, 55°, and 60° C., it was found that the thermophilic organisms are active ammonifiers. The effect of alternating temperatures shows that there is an increasing ammonification as the alternating temperatures were made higher; and that the rate of the ammonification process is the same whether the variation of the alternating temperatures is 15°, 10°, or 5° C.

Nitrification. The effect of constant temperature shows that the process takes place between 15° and 40° C., and that the optimum temperature seems to be about 35° C. The effect of alternating temperatures shows that there is a constant increase of nitrate formation as the alternating temperatures were increased up to 35° C., but the amount of nitrate nitrogen formed was much less than the amount of nitrates accumulated with constant temperature, indicating that the alternating temperatures inhibit the formation of nitrate nitrogen. It is also noted that greater variation of temperature, such as 15° C., is more favorable to nitrification than the smaller variation of 5° or 10° C.

Denitrification. In the study of the effect of constant temperature, it was found that denitrification takes place between 15° and 40° C., and that the

optimum temperature is somewhere between 25° and 30° C. The study of the effect of alternating temperatures indicates that no result of practical value could be obtained by the technique now in use.

Nitrogen fixation. In conducting this experiment the effect of temperature was studied in connection with ærobic and anærobic conditions. Under anærobic condition, the environment was so made that the organisms were forced to live as facultative anærobes. The effect of constant temperature shows that nitrogen fixation, both under ærobic and anærobic conditions, takes place between 15° and 40° C., and that the optimum temperature for both conditions is between 25° and 30° C. The study of the effect of alternating temperatures was not undertaken.

—*Abstract by Elias H. Pañganiban.*

EXCHANGE NOTES

There is an old saying which reads "Seeing is believing". Those who have read about vitamines A, B, C, and D—those very interesting and important elements in our food which keep our bodies in good condition—will be glad to know that after much research work vitamine D has been isolated so that it can be seen. It appears to be a crystalline white substance, somewhat resembling quinine. Although it is important in our diet, especially to overcome rickets, its discoverers are not going to make it into a patent medicine. We won't have to worry about taking it as medicine, as we get it in sufficient quantities if we eat fresh fruits and vegetables for that is where it is found most abundantly. Fresh tomatoes and oranges contain vitamine "D" in large quantities.

—*The Prairie Farmer* (Illinois).

Fewer farmers are producing more crops now than were produced in 1910. At that time the average amount of land handled by each man engaged in farming in the United States amounted to 24.6 acres. In 1920 it had increased eight acres, jumping to 32.6 acres per man, or an increase of over 24 per cent. At the same time, the total volume of crops produced increased by 15 per cent.

This has been brought about largely by the greater use of labor-saving machinery, such as tractors, gasoline engines, automobiles, trucks, and good roads.

—*The Progressive Farmer* (Alabama, U. S.)

Java maintains her leadership in cane sugar production in the Far East. She has been the beacon light of hope for various countries situated in the eastern hemisphere. The land has been the great vantage ground of the Holland-Indian possessions from whence have radiated remarkable influences.

Java has a record of over two hundred years of activity in sugar manufacture. As early as 1710, Batavia alone had 130 sugar mills. For fear there would be an overproduction each mill was held to an annual output of 18 tons and because of this stringent regulation the number of mills in 1745 was reduced to 65. But Holland's persistency to maintain the industry ran the number in Batavia up to 82 in 1752 which number again fell to 55 in 1779. Of these mills 24 were then in the hands of Europeans and annually produced 100,000 piculs of sugar. The Chinese originally manufactured the sugar and delivered it to a Dutch company and this corporation for years engineered the industry. When it was dissolved the government of Holland took control of the mills. . . . . It is the irrigation waters that insure Javanese success and it has been estimated that every kilogram of sugar needs 1,000 liters of water to bring about its consummation. Originally the period of rental of cane plantations was 3½ years, but as this did not give a long period of guarantee to the manufacturers who wanted a steady flow of cane, the government raised this to 21½ years. . . . .

Should Java ever lose her sugar industry the 200,000,000 florin profit would mean a loss of 175,000,000 florin to the native Javanese. The rest of the profits go to Holland and Chinese factory owners. The sugar factories employ 4,000 Europeans, and 50,000 Javanese, and during the campaign from 700,000 to 800,000 laborers find employment in the fields and factories.

—*The Planter and Sugar Manufacturer.*

Mosquitoes are found everywhere on earth except at the poles and in the deserts; and it is estimated that not less than 700 species ply between the equator and the far north. They breed in either fresh or brackish water, and their life history, which is not unlike that of other aquatic insects, has been made rather familiar of recent years by reason of various public campaigns against the pest, following the discovery that certain species transmit malaria, elephantiasis, yellow fever, and other dangerous diseases.

—Ida M. Mellen, *Zoological Society Bulletin.*

The use of oiled paper for packing apples is on the increase, says the Agricultural Gazette of New South Wales of December, 1924. Between 12 to 15 million boxes were wrapped this season. The use of this paper is said to have had the effect of preventing, or much reducing, damages by scald in common or cold storage, or in transit.

—*The Journal of the Madras Agricultural Students' Union.*

Hens fed milk in galvanized containers are subject to zinc poisoning, say poultrymen at the state agricultural college. Use wooden, earthen, or porcelain containers.

—*California Cultivator.*

Editor Prairie Farmer:—I have found the simplest and best way to test the fertility of eggs in an incubator to determine if they are infertile. I extend my egg trays from one table to another, in a dark room, and place a flash light close to the bottom of the eggs on the tray.

With this method you can easily see the eggs that are clear and those that are good. I test 500 eggs in 15 minutes this way.

—James Christenson, *The Prairie Farmer.*

COLLEGE AND ALUMNI NOTES

Honorable Rafael B. Palma was inaugurated as President of the University of the Philippines on July 18. The ceremonies on the occasion were marked by simplicity and dignity.

President Palma was a Campus visitor from July 25 to 28.

As an expression of their esteem and in honor of his inauguration, the faculties, resident alumni, and student representatives of Los Baños Associated Colleges and School gave a dinner to President Palma on July 25. The "Y" hall by the artistic use of flags, palms, and colored lanterns was transformed into a cheer-

ful banquet room. On tables gay with flowers from our campus, covers were laid for one hundred guests. The dinner was prepared and served under the direction and by the actual aid of the Nutrition Division of the Chemistry Department. And a very good dinner it was.

At the speakers' table were the guest of honor, Dean Baker of the College of Agriculture, Dean San Agustin of the College of Veterinary Science, Doctor Espino, Professor Yule, Doctor Santos, Doctor Uichanco, Doctor Tubangui, and Doctor Mendiola. Doctor Espino acted as toastmaster. Mr. Hollera, president of the Student Body of College of Agriculture, spoke for the students of the Associated Colleges.

The guest of honor in his response expressed himself as deeply touched by the tributes paid him by the speakers and by the loyalty expressed to him in his official capacity and to the University.

A violin solo by Mrs. Elias Pañganiban with Professor Roa at the piano and selections by the College Orchestra added to the pleasure of the evening.

Miss Margaret Wilson is a recent addition to the English Department Staff. Miss Wilson is a graduate with degree of A.B. from University of Wisconsin. For three years she was connected with Shantung Christian University at Tsinan, China.

At the meeting on July 30 of the Los Baños Biological Club the following papers were read:

"Phytophthora disease of eggplant." By Dr. G. O. Ocfemia.

"A study of the breeding efficiency of cows under range conditions." By Dr. V. Villegas.

"Clinical observations on epizootic lymphangitis." By Dr. C. H. Schultz.

Under the initiative of the Faculty Committee on Athletics of the College of Agriculture a departmental athletic league was organized to promote athletics among the students of the Associated Colleges of Los Baños. The students majoring in each department constitute the nucleus of membership of each aggregation, and all other students affiliate with any department of their choice. Indoor baseball, basket ball, volley ball and football games will be played by the competing ten departments. The league was inaugurated with appropriate ceremonies on July 25. President Palma, Dean San Agustin, and Mr. Santos, Physical Director, spoke. Doctor Gonzalez acted as master of ceremonies.

Doctor Mendiola, Doctor Fronda, and Professor Lopez are now residents on Faculty Hill. Doctor Mendiola occupies a cottage on Forest Road and Doctor Fronda and Professor Lopez cottages on Copeland Plaza. Professor Johnson is now living in the Herbert cottage.

The Implement Bodega, a fine concrete structure, is now completed. This building will house all implements and tools belonging to the College.

Another notable Campus improvement is the surfacing of Copeland Plaza Road, which extends from Forest Road to Copeland House.

Mr. C. Crucillo, '25, now employed in the Extension Division of the Bureau of Agriculture, writes Doctor Fronda that he has been having a varied experience in being "broken in" in his new work. He has worked at Singalong Experiment Station in different kinds of nursery work; at Lamao, in horticulture; at Alabang, becoming familiar with animal and rice projects.

After a recent encounter with one of boys in which Joaquin Amenabar, second year preparatory, was cut in the hand he voluntarily secured the withdrawal of all charges against his assailant both in court and in College. This was an exhibition of high grade sportsmanship which the Dean has recognized in a personal letter to Mr. Amenabar.